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ABSTRACT

This is one of the outcomes of the work of the Massachusetts Evaluation Service Center for Occupational Education (ESCOE). After an overview of the Performance Test Development Project, a summary of the major products and byproducts is presented. The major products are: (1) a set of clearly defined, well-structured, and consistent behavioral objectives, usable in the development of criterion-referenced test items; (2) a set of criterion-referenced test items, associated with these objectives, which form the basis of an item bank; and (3) a course guide for teachers on the use of the objectives and items. Useful byproducts include the process of objective and item development, the model items for the area of electronics, the creation of a consistent format for the production of objective and item cards, and materials for teachers and State Departments of Education. The remainder of the report elaborates on criterion-referenced measurement, item banking, the processes of item development, item analysis, and a teachers' guide to test construction. Included in the document are a seven-item bibliography and two appendixes, a proficiency examination for prospective candidates for a vocational teacher program, and a 77-page sample of computer output from an objective and item bank. (Author/BP)

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FINAL REPORT

Evaluation Service Center for Occupational Education

APPENDIX G:

Criterion-Referenced Item Banking In Electronics

by

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OVERVIEW OF THE PERFORMANCE TEST DEVELOPMENT PROJECT

Background

The 1968 Amendment to the Federal Vocational-Technical Education Act mandated the development of state-wide evaluation systems for the administration and operation of federally supported vocational education. Parallel to this mandate the Research Coordinating Unit director for the Commonwealth of Massachusetts was in the process of completing some predesign activities for the development of a vocational-technical education management information system. By 1969 the predesign of this system had moved into the feasibility stages and specifications of the system were being developed.

At this stage of development New York State, which already had a fine centralized testing program, became interested in the philosophy espoused by the Massachusetts system and joined in the funding of a more intense feasibility test, which eventually became the source of the Performance Test Development Project. The Evaluation Service Center for Occupational Education (ESCOE) was funded in July 1971 and was housed in Amherst, Massachusetts, to test the feasibility of systems development based upon the principles of (1) local control and development of vocational curricula, (2) data-based feedback based upon tailored performance tests, and (3) curriculum description through terminal behavior objectives. The following report deals with a subcomponent of the ESCOE system which was designed to develop performance tests as software support for the ESCOE program.

Whats and Whys of Performance Testing

Performance testing is more a new reality as opposed to a new concept in educational testing. The concept grows out of the need felt by educators to sample actual performances of trainees as opposed to merely measuring symptoms of desired (or intended) competencies through paper and pencil tests and then relying upon the predictive powers (i.e., previously established associations of paper and pencil test scores to some hypothetical or observed criterion of competency in performance) of the test to infer competency acquisition. This felt need has grown in part from the inability of standardized achievement tests to deal with the unique objectives of a specific educational program, in part from the reportedly low correlations between measured skills and on-the-job (or in-the-shop) performances, and in part from the lack of realism involved in the paper and pencil testing situation.

Hence the performance test can be conceived of as a criterion-referenced test, in that (1) it is objective or criterion-centered (in one-to-one correspondence with the extant component of a stated objective); (2) it seeks to ascertain a subject's possession of a specific competency rather than to complete a comparison of the subject's competency level to a previously measured norm group; and (3) it usually requires a dichotomous decision as to whether the competency has been demonstrated. The performance test can be construed to be a special case of the criterion-referenced test in that there is a definite attempt to establish fidelity between the sample observation of the performance test and the performance being sampled.

In the evaluation of instructional programs in vocational-technical education, the concept of performance testing is especially appropriate for several different reasons. First, performance tests can be hypothesized to produce more relevant and valid date concerning the instructional program output. Vocational program objectives tend to deal with competencies which require concurrent behavior changes across several domains of instructional objectives.

Hence the accomplishment of a vocational objective may depend upon the development of a psychomotor skill, the mastery of a cognate process, the acquiring of some fundamental facts, and the development of a particular attitude. Unlike paper and pencil tests, which emphasize the measurement of the cognitive aspects of the performance or observations which emphasize process and action components, performance tests possess the potential to measure the mixture of behavior domains appearing in the desired performance. The performance test can therefore be argued to offer a valid means of measuring intended outcomes.

Second, performance tests produce product records which can be studied by teachers to diagnose the place in the instruction where a weakness may have occurred, aiding considerably their ability to analyze their instructional methods. Since the teacher can determine what aspects of the competency are missing, he can trace the point in his instruction where his objectives were not met. Also, since the product is concrete it can be kept longitudinally to analyze pupil growth at different stages of a multi-year program.

Third, the nature of the data produced by performance testing contains the flexibility demanded by the information needs of an evaluation system. The tests are constructed in one-to-one correspondence to stated objectives, thus enabling selection of test components from a data bank situation in such a manner as to tailor the testing to the measurement of a unique set of program objectives. Since the tests are objective specific, comparisons of small aspects of an instructional program are possible. Since the tests are criterion-referenced, skill attainment in a particular area of interest can be ascertained; hence output of instructional programs can be described relative to percentage of skill development.

Restraints on Test Development

The design of the performance tests had to take into account both the philosophical and the operational structure of ESCOE. At times both of these structures served as restraining and occasionally frustrating hurdles for the test development team.

The philosophical nature of ESCOE provided the foundation of principles which are believed to have caused the performance tests to be unique. Since the objectives were generated by each local school, several very similar objectives appeared for a single behavior within a subject. Dr. David Berliner, now with the Far West Laboratory for Educational Research and Development, invented a process to state these similar objectives into a synthesized form accompanied by item changes providing for the unique characteristics of each objective. Thus, if enough objectives from different schools were collected to represent the curricula, by synthesizing those objectives one could arrive at a statement of all desirable behaviors within one curriculum.

The raw objectives based upon the curricula of each of the participating schools were synthesized to identify the major behaviors within a curriculum area. Hence, if the process worked ideally within a curriculum area a linear set of behaviors was produced. The degree to which this process failed to produce such a linear array of behaviors comprised the first major restraint. If a singular listing of behaviors could not be gained, then singular test items could not be written.

A second philosophical principle which developed into a restraining factor was the decision to test only locally-maintained objectives within a specific program. This principle actually involved several implications for testing. First, a student would be tested only on the objectives maintained by the curriculum he was receiving. Therefore, the test items had to be described in a form indicating one-to-one correspondence with the synthesized objectives so that the local teacher could select only those items maintained for his course. This selection pattern, however, did increase the logical assumption that the tests possessed high validity in regard to the courses for which they were designed to measure outcomes. Second, each item had to be independent in its ability to be administered, since previous or adjoining items would not necessarily be administered with it. This item independence served as a restraint to test development in that objectives could not be clustered into tasks involving several test items.

The third restraint involved both philosophical and operational aspects in that two forms of scoring were preferred by the two cooperating states. Philosophically, the state coordinators differed on the location of scoring; this disagreement became a restraint to test development in that the items developed had to be scorable both in the local school and at a central test center. Three forms of scoring meeting this restraint were adopted, with choice of scoring form depending upon the nature of the individual item. Two of the forms are based upon meeting the restraint with a single scoring process. The third form requires two different processes in order to meet the dual scoring restraint.

The scoring approaches requiring only one process are (1) the caliper or mechanically scored form and (2) the selection of correct response form. In the mechanically scored approach, several measured settings can be placed in a test scoring kit; the student or teacher records by label which of the settings fits the final product. A key of correct setting labels can then be referred to, producing a dichotomous score for the product in terms of size tolerances. In the selection of correct response approach, correction keys can be applied directly to the students' responses. In both cases either a central office or an individual classroom teacher can use the keys.

The third scoring form is not as simple, since two types of scores are required to meet the dual-use restraint. This scoring form is necessitated by the many tasks in the vocational curriculum which require expert observer judgment for the determination of performance quality. The two types of scoring needed for these items are (1) structured criteria for observation, and (2) pictorial records (color-coded to facilitate central scoring). The structured criteria for observation communicate to the teacher what aspects of the product to check in order to judge the performance successful. These criteria would be used in class. In the pictorial scoring process, camera angles have been described which would allow Polaroid pictures to be taken as records of the finished product. Color-coding the criteria checks would enable observers in a central location to determine the quality of the performance.

Each of these three approaches provides a means through which credible and unbiased scores can be obtained. All of the processes can be scored by individual teachers and used within a classroom setting without the aid of a central scoring station. The fourth restraint to test development arises at this point, since it is impossible to arrive at an immediately usable set of norms through the current scoring system and the dichotomous item response without implementation of a program designed to gather enough data to norm the tests.

Two other restraints were present throughout the test development project, both operational in nature. First was the quality and quantity of the behavioral objectives themselves. Few if any of the curriculum areas were fully described, and the tests developed are limited to described curriculum. In two test areas, more items were developed and the synthesization process was repeated in order to sharpen the synthesized objectives. In these cases much curriculum had been left undescribed and the fill-in process aided considerably in explaining the descriptions. However, complete and multiple sets of items were not available from each school; therefore the test items may be lacking in content validity in cases of consultant-written items, may be representative of several behaviors, and may hence be difficult to test or represent only a small segment of the previously unwritten curriculum.

The second operational restraint was that of time. Although the budget was small, the seriously close deadlines in development work made time an even greater restraint. Creativity is sometimes especially evasive under deadlines and within the constraints of administrative conflict. Still, the time dimensions were met in terms of design. Since schools were closed during the critical month of June, illustrations of some items of the tests could not be produced; therefore only plans, item descriptions, materials descriptions and administration instructions could be developed.

A final restraint can be observed in the language in which the proposal was written. First, several terms apparently changed in meaning or in relevance to the project once development began. One apparent change occurred in the description of sixteen tests for four areas. One test for each level of a curriculum area cannot be developed so as to be equally relevant to all schools. Since the schools maintain different objectives, different items must be assigned to each school, even on the same level. Hence a more appropriate process becomes the development of an item bank from which tailored tests can be developed for each individual program. Second, the time restraints and the differences in nature of curriculum required different kinds of tryouts, making the language of the proposal seem sometimes inappropriate.

Purposes of the Test Development Project

The design of the test development project included not only the goal of producing tests as products but also the goal of establishing feasibility of the test development effort across a broad spectrum of vocational-occupational curricula. For this reason four different areas of vocational curricula were selected for test development. These four areas differed in hypothetical difficulty of test development. The areas chosen were machine shop, woodworking and carpentry, electronics, and automobile mechanics. The automobile mechanics area was hypothesized to be the most difficult since manufacturers determined the curriculum, which therefore differed across competing manufacturers.

The performance tests were hypothesized to be sufficiently flexible to fulfill many purposes of a comprehensive evaluation system. Because of their proximity to the desired outcomes, performance tests were hypothesized to serve as (1) student diagnostic and prerequisite instruments, (2) diagnostic instruments for the analysis of instruction, (3) criterion instruments, (4) measures of classroom achievement, and (5) program success indicators. Each of these uses has already been piloted to some extent.

The performance tests as developed have several application conveniences. First, since the test items are paralleled to synthesized objectives, computer selection of test items or "synob" comparison of items can be used as a methodology for tailoring tests to instruction. Second, since the conceptual frames of the tests can be described, each test has built-in potential updating or extension by the classroom teacher.

Problems Encountered

Problems occurred from three viewpoints. First was the problem of lack of known direction, a handicap which often occurs in the area of development. Second was the problem of lack of perfection or completion of the objectives used as raw materials for the development of test items. Third was the problem of contending with dual scoring requirements and with several different kinds of program emphasis and structure.

The first problem has been emphasized recently with the development work done on criterion-referenced testing. From a conceptual point of view, the criteria previously used to determine the quality of norm-referenced tests can no longer be used for criterion-referenced tests. Since the measurement strategy of the criterion-referenced test and the performance test is to determine the possession of either a skill or the capability to carry out an activity or process, the degree to which the test differentiates between subjects taking the tests does nothing to indicate test quality. Unlike the norm-referenced test, in which measurement strategy is to distinguish between subjects, the performance test cannot be hypothesized to produce large differences across subjects nor can any specific level of difficulty be expected. Hence, average levels of difficulty and large differences between subjects do not indicate quality of the performance test.

In performance testing, some concepts of reliability still appear useful, while others appear to have lost their relevance. Reliability over time, or test-retest reliability, is still meaningful as long as the time between tests did not include opportunity for the subject to acquire the skill in question. Since performance tests are designed so that each item does not necessarily refer to the same skill or activity, reliability indices dealing with homogeneity of the test no longer appear to be relevant criteria for test quality.

The degree to which the items of a performance test cover the skills of an area and approximate actual required performances operates in a similar relationship to the performance test as that of a prediction index to a norm-referenced test. This degree of similarity might be compared to the concept of fidelity so often used in the recording industry.

The second problem area involved the quality of the raw materials used. As should be expected, the synthesis process does not apply evenly to all areas and was not applied with the same consistency to each set of objectives. In the machine shop curriculum area, between 70 and 80 percent of the content was described by the objectives. These objectives possessed adequate depth across skill areas to enable the synthesis process to produce clear synthesized objectives describing unique performances. The creation of items parallel to the synthesized objectives and possessing the independence and flexibility required by the philosophy of the system was a straightforward process.

In the woodworking area, between 60 and 75 percent of the content was described. Unfortunately, the synthesizers of the raw objectives failed to produce synthesized objectives which dealt only with single performances. Instead, the raw objectives were synthesized by similar or related behaviors and the product of this process was a matrix of similar performances (rather than a single performance) with several form changes denoting differences in conditions and extents across schools. Since these products seemed usable, the decision was made to produce a matrix of test items generated in one-to-one correspondence to the performances included in each synthesized objective.

this decision was the source of some time lost due to the expanded number of test items which had to be written; however, this increase in items was accompanied by a large increase in test specificity, which increases the degree to which the performance test can be tailored to fit a given instructional program without any noticeable loss of efficiency of the item banking process.

Due to the variance of material and the limited scope of the objectives developed for the electronics curriculum area, a decision was made to rewrite many of the synthesized objectives. For more than one-half of the contract period two of the test development team members struggled to find a format within which the scope of the electronics curriculum could be described. By expanding the number of conditions it was found that classes of performance could be described by synthesized objectives. Hence, through considerable redesign and a small set of compromises of the synthesis process involving uniqueness of performances and allowance of performance form changes, sub-collections of electronics objectives could be written which would allow test development along similar conceptual lines as those followed in the development of the machine shop test. Results of the test development effort again produced item banks, as in the two previous test areas, with the items possessing similar relationships to the synthesized objectives.

In the area of automobile mechanics, less than 50 percent of the content was described by the raw objectives. Many of the subdivisions of content were too sparse to allow for the development of synthesized objectives. In addition, the synthesis process applied seemed irregular across blocks and units. The level of abstraction of behaviors described by the raw objectives and the interdependence of the performances raise questions concerning the appropriateness of the synthesis process in this area. Certainly, the limited number of usable synthesized objectives and the necessary revisions of the existing objectives made the decision to rewrite the objectives essential. Revision of the curriculum descriptions were made in relationship to the job orientation of the curriculum. Test items were written around standard mechanics tasks as described in the automobile mechanics curriculum. In some of these items, synthesized objectives are tested in a format which includes a cluster of the objectives provided by the ESCOE system. In other items, only parts of ESCOE-produced objectives are included in the new synthesized objectives being tested. Once a test item has been constructed, the process can be reversed so that system capability as achieved in the other three test areas can be gained. Because of their time-consuming nature, tasks in the curriculum such as disassembly or reassembly of a motor or transmission were not included as complete test items. Instead, either sample tasks extracted from the large unmanageable task or written or pictorial selection items were created to test these phases of the curriculum.

The third problem area encountered was the difficulty involved in the existence of two separate scoring requirements and in the time limitations of the test development project. It was not always possible to produce useful in-class scoring of the performance item and credible, objective centralized scoring of the performance through application of the same scoring process. Therefore some items are suspected to produce more useful scores in the classroom than in a central scoring situation, while the reverse is suspected of other items. Only time and study of the tests can alter or affirm these suspicions. It is unfortunate that systematic refinement of the woodworking, electronics, and automobile mechanics tests is not planned to occur along the same lines as those applied to the machine shop test.

The following report includes development and field testing procedures, item bank descriptions, recommended analysis procedures and uses for one of the four test areas briefly described above.

Summary

Any research and development project produces a variety of products and by-products. The project to develop a set of criterion-referenced test items in electronics has created a variety of materials useful to educators which were not specifically called for in the contract specifications in addition to those required in the contract specifications.

Major products

The first major product of this research and development project is a set of clearly defined, well-structured, and consistent behavioral objectives each of which contains one observable behavior and, therefore, permit their use in the development of criterion-referenced test items. This set of objectives is derived from the original synthesized objectives provided by the Evaluation Service Center for Occupational Education (ESCOE). The second major product is the set of criterion-referenced test items associated with the objectives which form the basis of an item bank which can be used by teachers from all schools to create tests which are specifically tailored to their local and individual needs or can be tailored by some regional or state-wide educational agency to produce tests which contain a specific set of items for large scale evaluation. The third product is a short concise guide for teachers to enable them to use the objectives and items to construct tests for their own use in the classroom.

By-Products

By-products resulting from an initial research and development project can often prove of value equal to those of the major products of the research.

In the case of the development of objectives and items in electronics there clearly has been the creation of valuable by-products which can be used by future efforts in occupational education to extend the set of materials and practices which were mentioned in the preceding section. The first by-product of considerable interest to the personnel in occupational education is the detailed steps in the process of objective and item development in the area of electronics for the purpose of evaluation. This process had not previously been outlined in detail in any documents. The detailed guidelines provided in this report will also enable educators in other major occupational education areas to develop a consistent set of items and objectives which can be utilized both by their originators as well as other agencies.

The second important by-product is the specific set of model items created in the area of electronics. Each individual item is a model for future items. The changing of values for components or the changing of the basic circuit used in each of these items will create new items with very little investment of time and energy. Therefore, the items themselves become a pattern for creating a large number of articulate items for future expansion of this project.

The third by-product is far less obvious in importance than the preceding ones. It is less obvious to persons who have not actively engaged in creating item and objective banks which can be used actively by teachers in a school setting. This by-product is the creation of a consistent format for the production of objective and item cards. This format is highly flexible as seen by the set of items including diagrams included in our report. Without such a format for objective and item cards which can be followed by persons in a variety of different occupational education areas it would be impossible to create a large-scale dissemination of these materials. Although computers offer a distant future revenue for the distribution of objectives, in the near future, normal duplication processes probably will be used making the item cards very important.

The fourth by-product is a critique and reaction to the notion of synthesized objectives which were presented to the test developers. These objectives are of limited usefulness in their current form because of the multiple behaviors they contain.

Teacher products

The development of objectives and items in a consistent format in the area of electronics provides teachers and other educators with a flexible set of materials which can be tailored to a variety of different purposes. The objectives can be used to define curriculum goals to individual students, to other teachers and to administrators. The test items can be organized in many ways to provide quizzes, ten-week tests, or final tests; to provide curriculum evaluation instruments; or to provide district wide evaluation of pupils' achievements in the area of electronics. Any other approach to the development of tests using objectives would provide a much less flexible and useful product for teachers.

State Education Department products

Already the objectives and items have been used for a proficiency examination for prospective candidates for vocational teacher program (See Appendix A). They may also be used for certification examinations and state-wide testing. The system of [illegible] materials is a model which can be used to generate a state information system which is compatible with an existing computer system (See Appendix B).

Criterion-Referenced Measurement

Criterion-referenced measurement is a new concept in educational measurement. It has been developed from a need to handle the specific requirements of a performance-based or objective-based curriculum and the decisions teachers and educators desire to make when teaching with these curriculum types. The basic definition for criterion-referenced measurement was stated by Robert Glaser (1971) as: "A criterion-referenced test is one that is deliberately constructed to yield measurements that are directly interpretable in terms of specified performance standards." This basic definition describes the essential components of cirterion-referenced measurement. The basic requirement is that the test is deliberately constructed so that the responses of individual students can be related to a set of performance standards. In the case of the Evaluation Service Center for Occupational Education, the performance standards are described in terms of behavioral objectives. These behavioral objectives must be stated so that there is a unique relationship between an item and the standards. It is not appropriate to have a statement of a performance standard imply a variety of different performances, each of which implies different standards. Therefore, initially the standards must be developed and then the individual test items can be developed to yield measurements which can be related back to these standards.

The process of creating the adequate measures which can be related back to specific performance standards have been discussed by a variety of authors (Gorth and Hambleton, 1972). Many of the rules which have been established and well-documented for the development of tests which do not have the primary goal of yielding measurements directly related to performance standards are not useful in developing criterion-referenced tests. The criterion-referenced tests are developed primarily to be used to make absolute judgments about students rather than relative judgments about one student compared to another. Tests to make relative judgments can also be developed following different, well-defined rules. The rules for developing criterion-referenced tests are not nearly as well documented. This report provides a basis for this process in the area of occupational education.

The construction of criterion-referenced tests where each item is clearly related back to a specific single performance standard must be conceptually separated from the use to which the criterion-referenced tests are usually put which is to describe the specific status of achievement either of pupils or of a program (to teach pupils the specific objectives defined in the performance standards). The use made of norm-referenced tests is considerably different. It is primarily used to rank pupils or programs along some continuum and to use this ranking as a basis for decision-making of one student relative to another or one program relative to another. This process is not the primary function of criterion-referenced tests. Therefore, the rule for developing criterion-referenced tests are different from those of norm-referenced tests.

Item Banking

Today's modern forms of education often build upon performance-based curriculum. The performance-based curriculum begins with a definition of behavioral objectives which form the educational goals or learning outcomes expected of students. The curriculum based upon behavioral objectives can be made highly flexible and individualized while theoretically maintaining a high degree of quality by carefully monitoring individual student progress and effectiveness of educational materials.

Although the performance-based curriculum allows flexibility, it requires an extensive use achievement test to adequately monitor the performance of individual students and of the program effectiveness. The extensive use of tests dictates that pupils be measured on their achievement of individual behavioral objectives before instruction, immediately after instruction, and on a retention basis. Many programs of pre- and post-tests exist as well as a more thorough form of evaluation called Comprehensive Achievement Monitoring (CAM) described by Gorth and Grayson (1969). These forms of evaluation require the development of a large number of test items, each of which is specifically related to one and only one behavioral objective. The test items must be independent of one another so that they can be grouped together in a variety of tests for a multitude of different purposes associated with a performance curriculum. The procedures for developing these test items related to objectives have become increasingly well defined and Glaser (1971) suggests several preliminary guidelines for these procedures.

In addition to providing detailed guidelines for developing individual test items related to individual objectives, procedures must be available for storing and retrieving these items in a systematic and efficient manner so that the items may be re-used in a variety of contexts to achieve a high degree of cost effectiveness. The procedures for systematically storing and retrieving items is usually called item banking. A variety of strategies for item banking have been proposed in the past including those proposed by Wood and Skurnik (1969) and Gorth and Grayson (1971). Both procedures rely heavily on the relationship of items to fixed content areas. The proposal by Wood and Skurnik does not explicitly define behavioral objectives but describes in detail the problems and processes of writing, critiquing, storing, and preparing tests. The proposal by Gorth and Grayson describes a computerized system which allows the storage of the behavioral objective and associated test items in a computer bank so that they can be quickly and accurately printed in a variety of tests for different purposes. An interim step to a computerized test bank will be described in later sections.

The ultimate rationale for developing an item bank in electronics is to provide educators, particularly teachers, with a set of highly articulate test items related to clearly defined behavioral objectives. These test items must be available for individual teachers to design tests for local requirements. Teachers must have the flexibility to devise, create, and construct their own tests for a variety of specific personal purposes.

Examples of computer output from the item banking system developed by Gorth and Grayson (1971) are shown in Appendix B. All procedures and formats used in this report are compatible with this computer system.

The Process of Item Development

The process of item development will proceed through several phases. The first phase of the development of criterion-referenced test items begins with the definition of behavioral objectives which contain only one performance under one condition with one extent. Behavioral objectives of this form must be written in detailed, but concise, language to clearly define the content domain within which test items are to be written. All of the information for the behavioral objectives must be specified in unambiguous terms allowing only one defined set of items to be constructed as measures of performance of these objectives. Rules for writing these objectives have been defined by several authors including Allan (1972).

After the objectives have been created, individual criterion-referenced test items must be written. Each criterion-referenced test item must contain a description of a situation which conforms to the conditions described in the behavioral objectives; each criterion-referenced test item must elicit behavior which parallels as closely as possible the behavior called for in the objectives. The scoring of each item must conform to the extent described in the objective.

After the item has been written in relation to a behavioral objective, the items must be critiqued by subject matter specialists and educational measurement specialists. After the items have been critiqued for readability by these experts, it is possible to use the items in a specific situation to identify the effectiveness of their performance. If the specific situation in which the items are to be used has not been carefully defined, the analysis of the validity of the items can not be determined. Items useful in one situation may not be in another situation. It is imperative that a clear-cut description of the educational environment and purpose of the items be defined.

The detailed account of the above procedures will be described below. These steps constitute a framework or guideline for the future development of objectives and items in electronics.

Stating Objectives

The process of stating behavioral objectives has become well-defined. A variety of different texts and guidelines exist for the definition of objectives. The text recommended by the authors for the initial development of objectives has been written by Allan (1972).

Revision of SYNOBS

Although a variety of guidelines exist for the development of objectives, the synthesized objectives (SYNOBS) provided to the test developers by ESCOE did not follow these guidelines in a fashion appropriate for further test development. Specifically, the SYNOBS in electronics contained multiple behaviors and did not follow a consistent use of equipment. Therefore, an extensive review of the SYNOBS provided by the ESCOE project was undertaken by the test developers. They were reviewed at three levels. At one level, SYNOBS identification numbers for which no SYNOBS existed were not further considered. Second, SYNOBS which proved inappropriate for the development of test items were discarded. The SYNOBS which were retained were re-written to contain one identifiable performance behavior. The steps for each of these different processes are described below.

Originally, objectives in the booklets of SYNOBS provided by ESCOE in electronics were numbered from one to 162. Within the range of numbers from one to 162, there were numbers for which no objective existed. These identification numbers are listed in Table 1.

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Table 1. Numbers for Which ESCOE Has No SYNOB

005, 006, 007, 010, 011, 020, 021, 024, 025, 028, 029, 030, 032, 044,
049, 092, 093, 096, 108, 109, 113, 115, 116, 141, 148, 151, 152, 157.

While reviewing the SYNOBS, the test developers discarded several for a variety of reasons. In Table 2, the list of SYNOB identification numbers which were deleted and the reason for their deletion are displayed. In particular, the most common reason for deleting objectives was that they clearly duplicated others. For instance, SYNOB #002 was a duplicate of SYNOB #138. The basic intent and purpose of both objectives are identical and only one was retained. In other cases, objective or units were considered inappropriate for electronics by the subject matter specialists. These objectives or units seem to have been included in electronics because other courses such as electricity, electric motors, household wiring, household appliances, and so forth, had not yet been defined, but would be more appropriate for the objectives. The last reason for eliminating objectives was their unrealistic nature. SYNOB #143 was submitted as a raw objective only by one teacher (who happened to be one of the subject matter experts used in the item writing). This objective was not taught in the school in which the teacher taught. On thorough examination the objective proved entirely unacceptable to a high school program because of its complexity,

Table 2. Numbers of Deleted SYNOB's and the Reason for their Deletion.

SYNOB number	Reason for their deletion
002	Duplicates SYNOB 138.
018	Duplicates SYNOB 013.
019	Unit inappropriate for electronics.
023	Unit inappropriate for electronics.
031	Unit inappropriate for electronics.
038	Objective inappropriate in electronics.
043	Unit inappropriate for electronics.
045	Unit inappropriate for electronics.
051	Unit inappropriate for electronics.
058A	Duplicates other objectives.
068	Same as SYNOB 069.
075	Covered by objectives in wiring from schematic and measurements on amplifiers.
079	Covered in wiring.
114	Unit inappropriate for electronics.
132	Unit inappropriate for electronics.
133	Objective inappropriate for electronics.
135	Unit inappropriate for electronics.
143	Objective inappropriate in electronics.
147	Duplicates SYNOB 145.
161	Duplicates SYNOB 003.

because of the fifty pounds of wire required, and because of the 40 to 50 hours necessary to complete it. This is an example of an objective which was eliminated because it was unrealistic for high school electronics.

A set of rules was generated by the authors to guide the revision of the SYNOBS and create a set of objectives which would become the basis for developing criterion-referenced test items. The set of rules included the following:

1. The writers read all electronics SYNOBS through once before any revision or re-writing. This provided a general background and identified similarities across objectives where simplifications and general revisions could be made.
2. The writers wrote one objective per page double-spaced with the objective number typed on the page along with the condition, performance, and extent. Further, each page included the block and unit numbers from which the objective was taken.
3. After reading all of the components of the SYNOB the subject matter specialist chose the central performance contained in the SYNOB. This central performance was used as the basis to create a new test objective. After deciding upon the central performance, appropriate conditions and extent were selected.
4. A terminal objective was written. All enabling objectives were assumed to have been previously learned and tested.

5. In choosing terminal objectives from a sequence of important objectives which may have been represented in the SYNOB, the subject matter specialist chose the most difficult objective of the sequence. For instance, if, in electronics, the SYNOB included a description of a series circuit, a parallel circuit, and a series-parallel circuit, the subject matter specialists wrote a terminal objective for the series-parallel circuit as the most difficult of the sequence. This allowed a testing of the terminal performance and allowed gathering of information on the prior performance.

6. For each objective which required the definition of a circuit, that circuit was defined in detail by specifying the number and value of all components, their configuration, and the development of a block or circuit diagram.

7. The generic names for all test meters, test equipment, and tools were used rather than the names of specific brands or types of instruments. This allowed individual schools to use the materials which they had on hand. (A terminal objective which must be included in each school's program would be the definition and use of the specific meter available in that school. Having mastered the use of that meter, no further testing would be necessary.)

8. The diagrams were specified as block diagrams or diagrams composed of standard electronics symbols.

9. In statements of extent the use of the term "calculate to slide-rule accuracy" was changed to read "calculate to three significant figures."

10. No objectives were to include the classroom activities which are often used to teach the objectives. In many cases, these classroom activities are preparatory to actually accomplishing the objective and need not be included in the final definition of an objective to develop test items.

11. When particular test equipment or test meters are used, the extent should be to the tolerance of the equipment or meters.

12. If at all possible, a VOM meter was specified rather than alternative types of instruments on the assumption that most schools have and use a VOM meter. This test instrument could be used for most objectives and test items. This would be most similar to the kinds of experiences a student would have on the job where he would probably have one meter to accomplish most commonplace measurements.

13. The subject matter specialists listed all objectives which were deleted and gave a reason for their deletion.

In revising the objectives there was a specific decision not to write any new objectives where gaps were discovered in the existing SYNOBS. The definition of new objectives was too extensive a job. Also, no structuring or sequencing of objectives was done.

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Objective Card

In developing a bank of objectives and items, a standard format is necessary to type and to file for easy storage and retrieval of individual behavioral objectives. Each behavioral objective may be used or not used for a particular course, program, or unit of instruction. An effort has been made to develop a standard format for individual objectives so that they can be stored on individual objective cards. These cards can be filed in a usual card file and each teacher can select individually the objectives which he feels are appropriate for his use and these objectives can be quickly photocopied and used for curriculum definition, for student exercises or for student definition of the curriculum. Without such a format and cards on which these objectives are recorded, each teacher would have to accept a standardized list of objectives which would not meet the requirements for local autonomy in the selection of objectives. Further, if the objectives are not prepared in a standardized format, each teacher would have to completely re-type and rearrange the objectives for his own use. For these reasons, the objectives included in the bank of objectives have been prepared in a standardized way.

The format for the objectives is shown in Figure 1. Figure 1 shows the blank objective card and the card with an illustrative example objective properly typed onto the card. The general format for these cards has been previously developed for academic use by Gorth and Pinsky (1968). These cards have been revised and designed for the particular use in electronics.

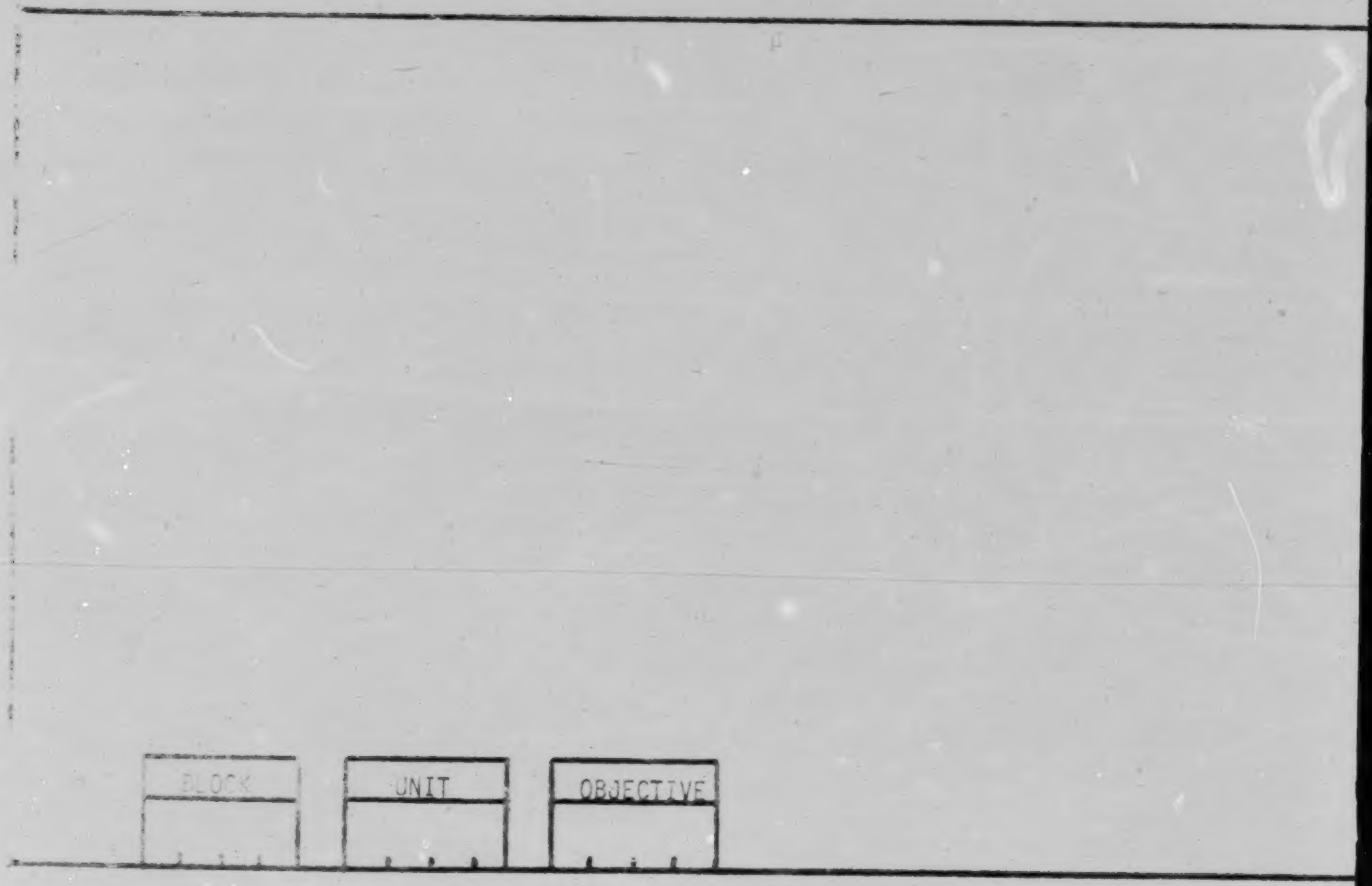
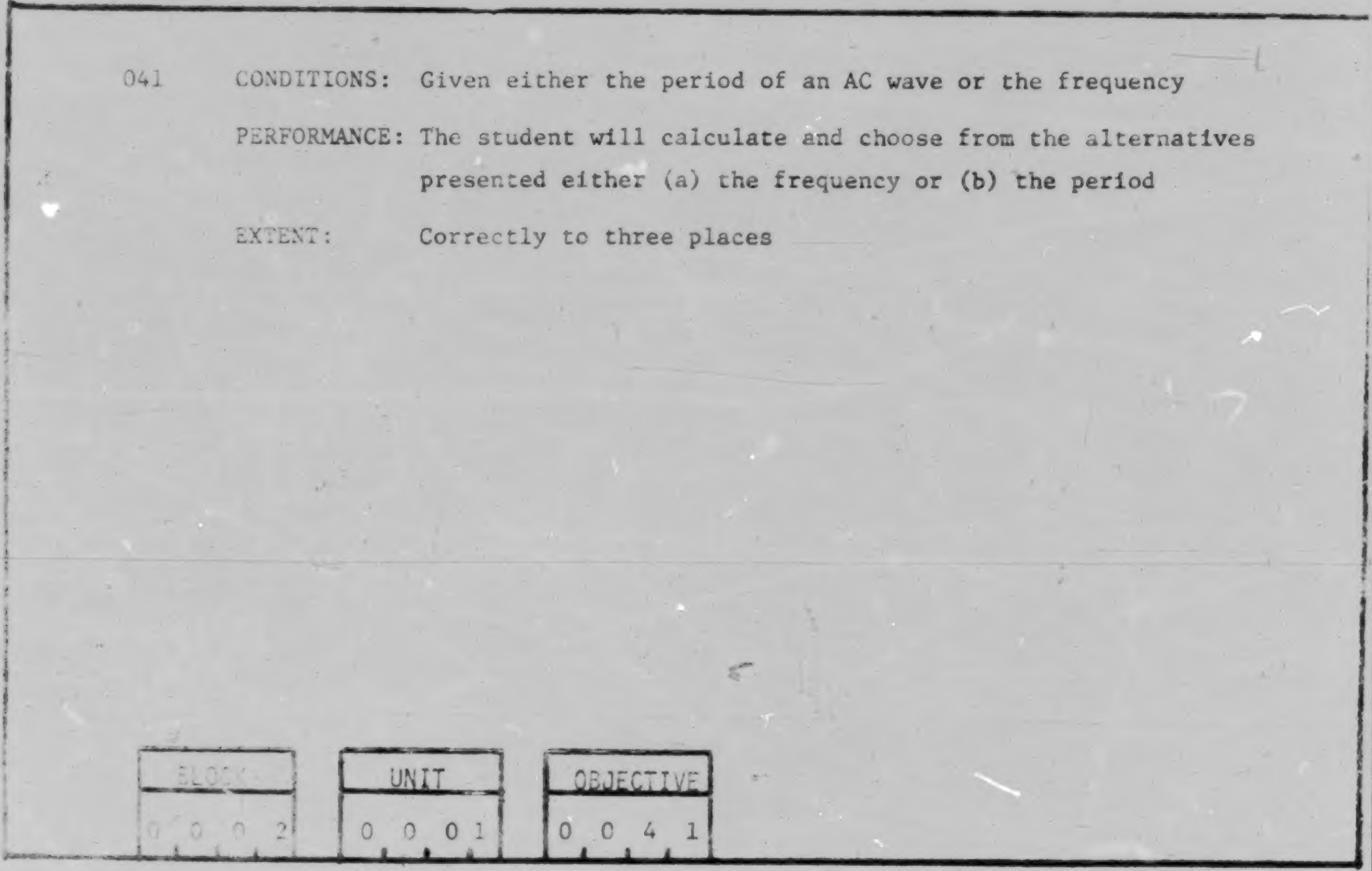

BLOCK
UNIT
OBJECTIVE

Figure 1a. Objective Card: (a) Blank To Be Used As a Master For Reproducing Additional Copies, and (b) Completed with an Example Objective In Correct Format.



041 CONDITIONS: Given either the period of an AC wave or the frequency

PERFORMANCE: The student will calculate and choose from the alternatives presented either (a) the frequency or (b) the period

EXTENT: Correctly to three places

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 1	0 0 4 1

Figure 1b. Objective Card: (a) Blank To Be Used As a Master For Reproducing Additional Copies, and (b) Completed With an Example Objective In Correct Format.

The general rules for typing information on the cards are as follows:

1. The margins are three-fourths of an inch left-hand margin and one-half an inch right-hand margin.

2. The card is an eight inch by five inch standard file card.

3. The objective number is typed one line down from the top of the card up against the left-hand margin.

4. The words "condition," "performance," and "extent" are typed indented the number of spaces necessary for the objective number plus one additional space. These words are typed in capital letters followed by a colon and arranged as shown in the examples.

5. The block number, the unit number, and the objective number are typed in the appropriate spaces provided at the bottom of the card.

All of the information on the objective card which is necessary to adequately identify an item will be repeated on each of the item cards for items associated with this objective. As will be seen in later sections, the item card was designed to be very similar in design to the objective card and allow quick filing in a common objective and item bank file. Modifications were made on the item card to handle the larger volume of information necessary for items.

Stating Items

Each of the criterion-referenced test items must be specifically constructed to relate to a behavioral objective which defines a unique performance. Each of the behavioral objectives stated in the previous sections describes a unique performance required of the student after he finishes his instruction. Each of the items generated in electronics will conform to the specific requirements stated in the behavioral objective. These requirements have been clearly defined during the creation of the objective.

Although in electronics the content could not be articulated and defined in as much detail as it can be in mathematics, each of the items, which has been produced, is similar to the item form defined by Hiveley, et. al. (1968). Hiveley described a "universe-defined" system of arithmetic achievement tests where each item on the achievement test was carefully defined in terms of the performance required such as addition, subtraction, and so on, and the set of numbers which would be included in the item. For example, one item might read: "Find the sum of number a and number b." Hiveley would then specify an item form as being all items constructed where the numbers a and b were replaced by other one digit numbers between zero and nine. Therefore, only a specified set of items could be constructed where one of the digits zero through nine could be combined with another digit to create individual test items. Each of the items in the electronics program potentially follows the same format. The project was not organized to define the specific limits of each of the different values which might be assigned to the instruments and components in the items. However, a subject matter expert would clearly identify specific reasonal values for individual components to take individual changes in components to make basically equivalent items. For instance, if a resistor of 1 ohm, 1 watt, and 5% tolerance is specified in the ESCOE item, a teacher can easily change the item to create a new item by using a 5 ohm resistor. (More complex substitutions are possible for tubes, transistors, circuit components or entire circuit configurations and diagrams.) In each case the basic constraints placed upon the item during its original creation must be maintained, but the variation in specific values of components allows the creation of new items which will tap the same skills and same achievement of students but with a different specific instrument.

Item Card

Purpose

An item card was designed to provide a standardized format for preparing, storing and retrieving test items from the item bank being created in electronics. Without a standardized format which could provide a means to file each item individually in some systematic fashion as well as allow easy location of each individual item the basic concept of an objective and item bank would not be met.

Format

The format of the item cards is closely related to the format proposed by Gorth and Pinsky (1968) for use in item banking in academic areas. Several important refinements have been included in the card format. In particular the concept of an extended item card to allow room for a diagram or figure directly on the card is different from the earlier versions of the item cards. Also the concept of quadrants is new which facilitates giving direction to a typist to type and prepare the individual item cards. The refinements facilitate the preparation, storage, and retrieval of items from the item bank and allow the items to be quickly duplicated in the correct format for tests. In addition, a third characteristic included on the item cards is the additional information to teachers concerning the directions to provide additional materials or information to students as part of the items. This additional information for teachers appears in the area nearest to the bottom of the card below the line of asterisks.

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Rules for Preparation

The rules for the preparation of item cards are explained in detail below. Examples of both the regular item card and the extended item card are shown in Figures 2 and 3. Each figure displays a blank item card, an item card with the quadrants which the typist would use as a frame of reference within which to type the text of items, and a completed item card including the text of a sample item, directions to teachers, and identification numbers shown.

The specific rules which have been created for item card preparation include the following:

1. The size of item cards is selected to correspond to usual readily available file cards for which file drawers are also available. The regular item card is five inches by eight inches. The extended item card is ten inches by eight inches in size. The extended item card, therefore, can be either two five by eight cards scotch-taped together or can be one large sheet of high-quality paper, cut to the appropriate size and folded for filing.

2. The margins on the cards equal three-fourths of an inch on the left and one-half an inch on the right.

3. The quadrants are marked off for both the regular and the extended item card in a consistent fashion. These quadrants should be used only as flexible guides to typing. If an item stem or alternative does not fit in the quadrant designed for it, it should be typed into the next quadrant. If the stem of the item does not completely fill a quadrant, do not skip to the next quadrant which

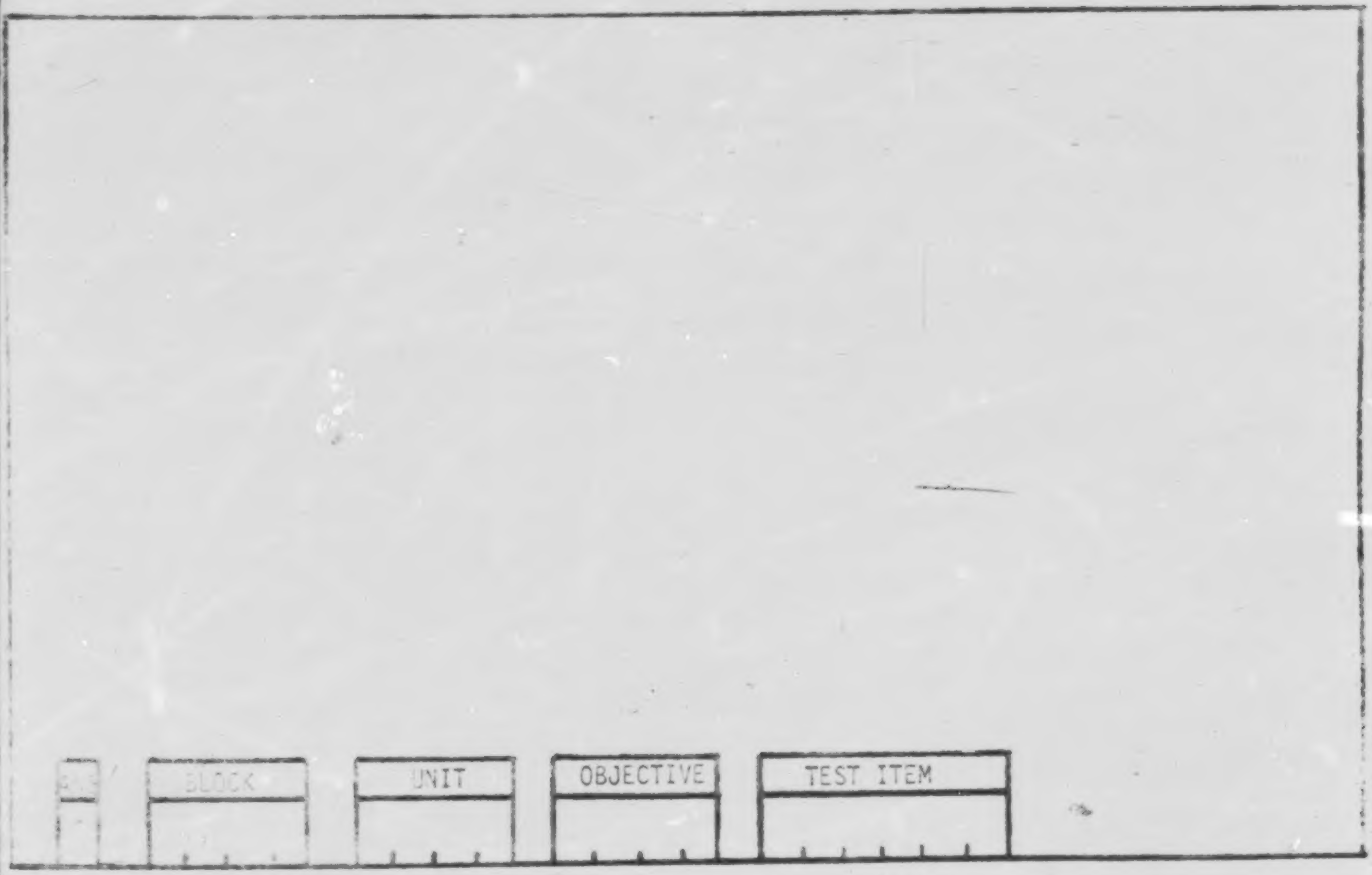

BLOCK
UNIT
OBJECTIVE
TEST ITEM

Figure 2a. Item Card: (a) Blank To Be Used As a Master For Reproducing Additional copies; (b) With Quadrants To Simplify The Description of The Format For Typing; and (c) Completed With An Example Item.

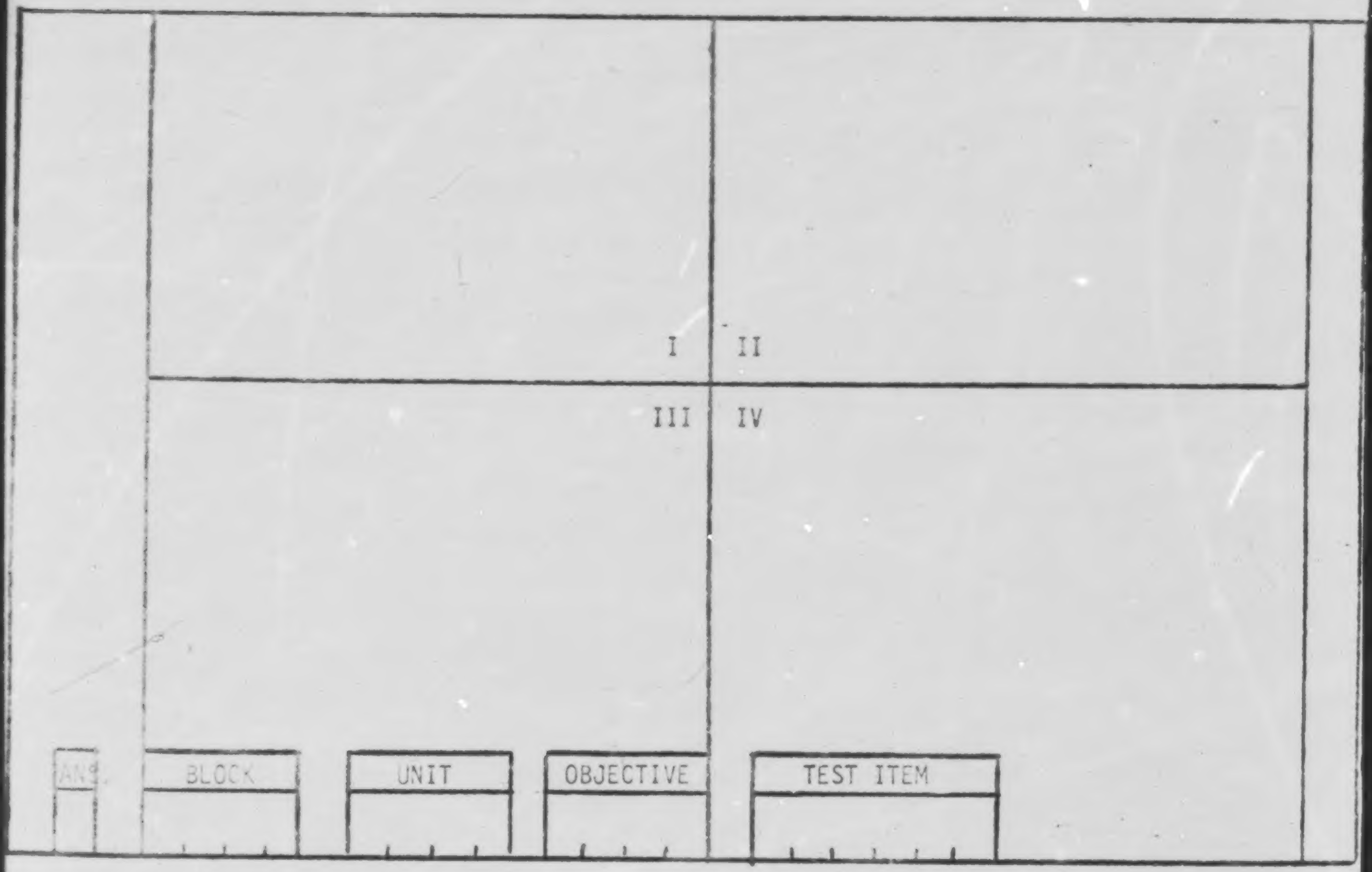
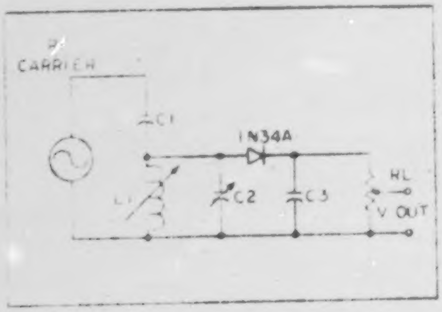

I
II
III
IV
ANS.
BLOCK
UNIT
OBJECTIVE
TEST ITEM

Figure 2b. Item Card: (a) Blank To Be Used As a Master For Reproducing Additional Copies;
(b) With Quadrants To Simplify The Description of The Format For Typing; and
(c) Completed With An Example Item.

C

Which statement is true about the Diode Detector circuit shown below?



A. The circuit above rectifies the r.f. carrier and C3 and R_L filters the r.f. leaving the information being modulated.

B. The circuit above rectifies the r.f. carrier and C3 and R_L filters the r.f. carrier leaving only DC on output.

C. The circuit above rectifies the information being modulated and allows the r.f. signal to go through.

D. The circuit above rectifies the modulated information and blocks the r.f. carrier.

BLOCK	UNIT	OBJECTIVE	TEST ITEM
0 0 0 3	0 0 0 4	0 0 8 0	0 0 8 0 0 1

Figure 2c. Item Card: (a) Blank To Be Used As a Master For Reproducing Additional Copies; (b) With Quadrants To Simplify The Description of The Format For Typing; and (c) Completed With An Example Item.

Figure 3 Extended Item Card: (a) Blank To Be Used As a Master For Reproducing Additional Copies; (b) With Quadrants To Simplify The Description of The Format For Typing; and (c) Completed With An Example Item.

Note: Figure 3a is on Page 29.
Figure 3b is on Page 30.
Figure 3c is on Page 31.

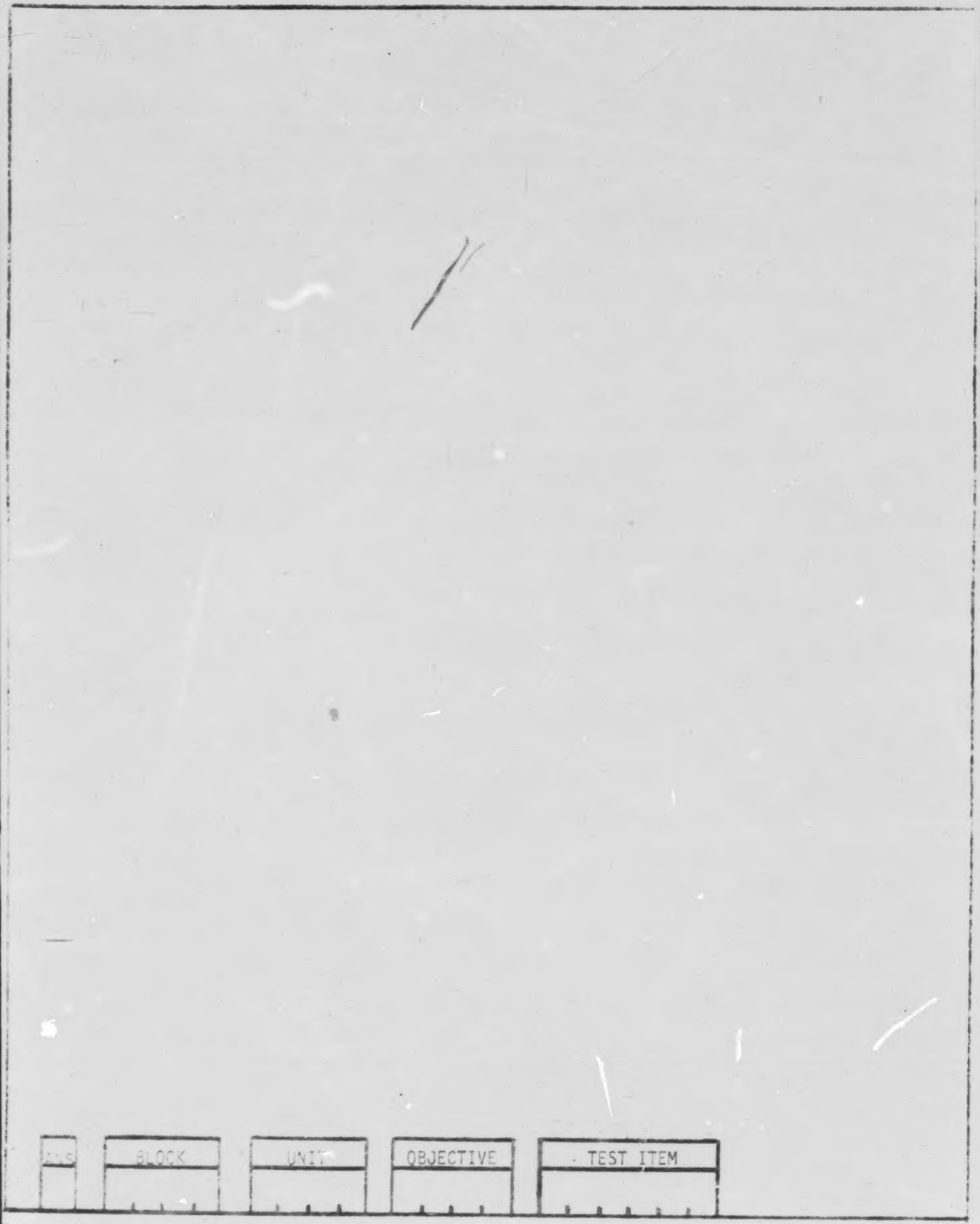
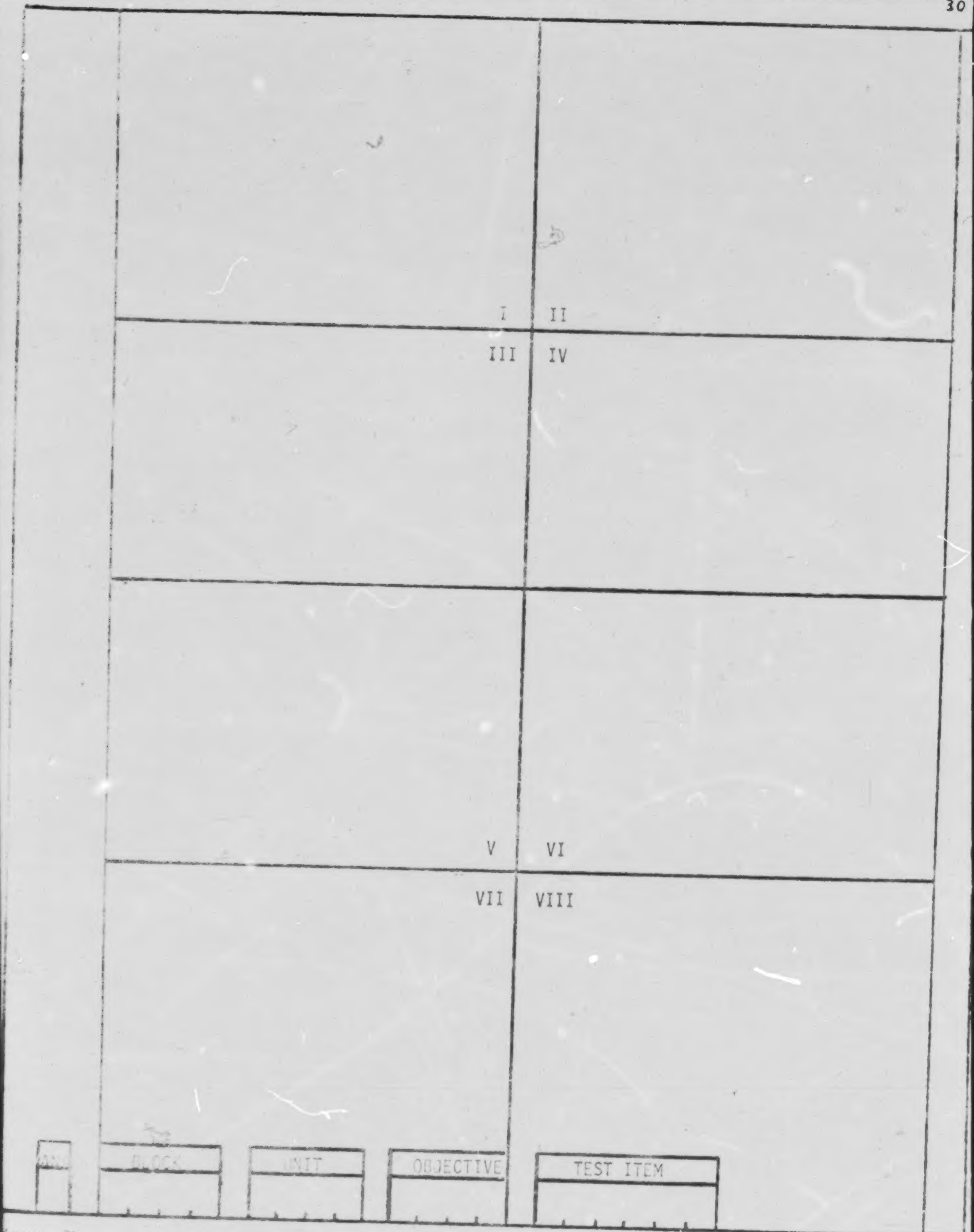

BLOCK
UNIT
OBJECTIVE
TEST ITEM

Figure 3a


I
II
III
IV
V
VI
VII
VIII
BLOCK
UNIT
OBJECTIVE
TEST ITEM

igure 3b

Plot the Zener current versus the Zener voltage in the forward and reverse directions by the following procedure and choose the curve which best represents your results.

i. Set up circuit given to bias Zener in forward direction as in the table below.

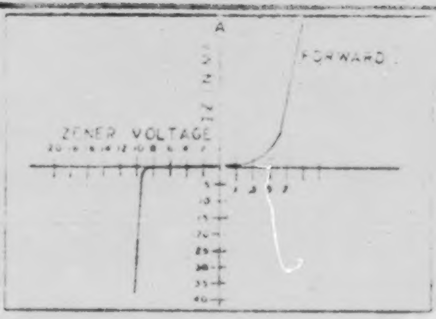
ZENER VOLTAGE	01	02	03	04	05	06	07
ZENER CURRENT							

ii. Set up circuit given to bias Zener in reverse direction as in the table below.

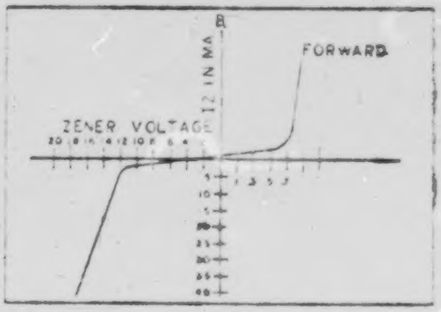
ZENER I IN MA		2	3	5	10	20	30	40
ZENER VOLTAGE								

iii. Plot the data you have recorded on one graph of Zener current versus Zener voltage.

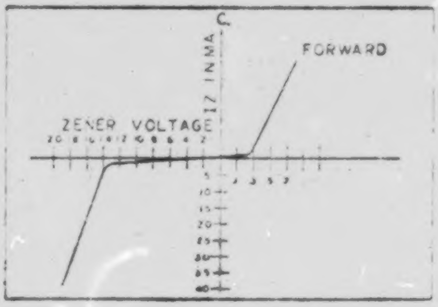
A.



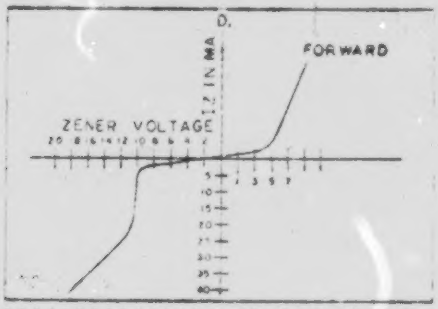
B.



C.

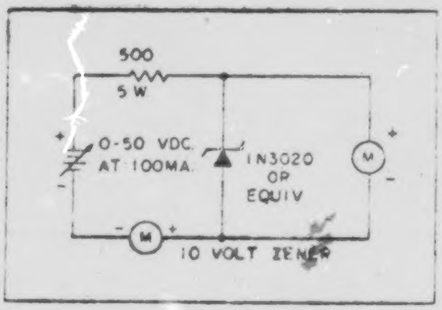


D.



****

MATERIALS: This circuit diagram and the components attached.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 5	0 0 8 3	0 0 8 3 0 1

Figure 3c

designated as the position for another part of an item, but continue directly below or to the right of the stem. The quadrants are only flexible guides indicating relative position.

4. When typing the text of the item, the item should be arranged to be as easily readable and clear as possible. However, in addition, it is helpful to minimize the length of the item down the page. Remember that the items will be arranged one after the other in a linear fashion down a page for duplication on a test form. The longer the items are, the more pages the test will require. If the number of pages on the test does not constitute a problem, any arrangement which is convenient is allowable.

5. Put the text of the test item which the student must read as close to the top of the item card as possible. Put the directions to the teacher as close to the bottom as possible. The teacher's directions should be typed under a line of asterisks and should appear just above the identification numbers for the item.

6. Make the stem of every item state a specific question or problem.

7. Put the alternatives to the question, if the question is multiple choice, at the end of the stem. Therefore, the stem of the question would be typed in quadrant I and the alternatives would be typed in quadrant II.

8. Label the alternatives A, B, C, D, and E.

9. When the stem of the item is typed, single space within the stem. Double space once below the stem before typing any additional

formation. Type the alternatives single spaced within alternatives, and in most situations, single spaced between alternatives. Only if the alternatives are difficult to read, should they be double spaced between alternatives.

10. Lable all diagrams with capital letters where possible, but do not use the letters A through E.

11. Put all diagrams either below or to the right of the stem of the item. Do not put diagrams above the item.

12. For laboratory and shop items, put the student question at the top of the card; near the bottom of the card type a complete row of asterisks across the page; then, type the teacher's instructions in the most compact form possible with the words "materials," "equipment," and "extent" typed in capital letters and underlined and used as side headings to indicate these components to the teacher's directions.

13. Use small Roman numerals to identify the steps which a student must proceed through in completing an item, i.e., i, ii, iii, iv, etc.

14. Type alternatives with decimal places and units lined up and have all numbers stated to the same degree of precision.

Diagrams

Each of the questions included in the item and objective bank which require diagrams were produced by the following general procedures. The writer of the item drew a rough sketch including all necessary components, component values and a general configuration. A final diagram was drawn using regular drafting tools and free-hand lettering. The final step was to have the diagram photo-reduced to a size appropriate for the item.

Rules for preparing diagrams

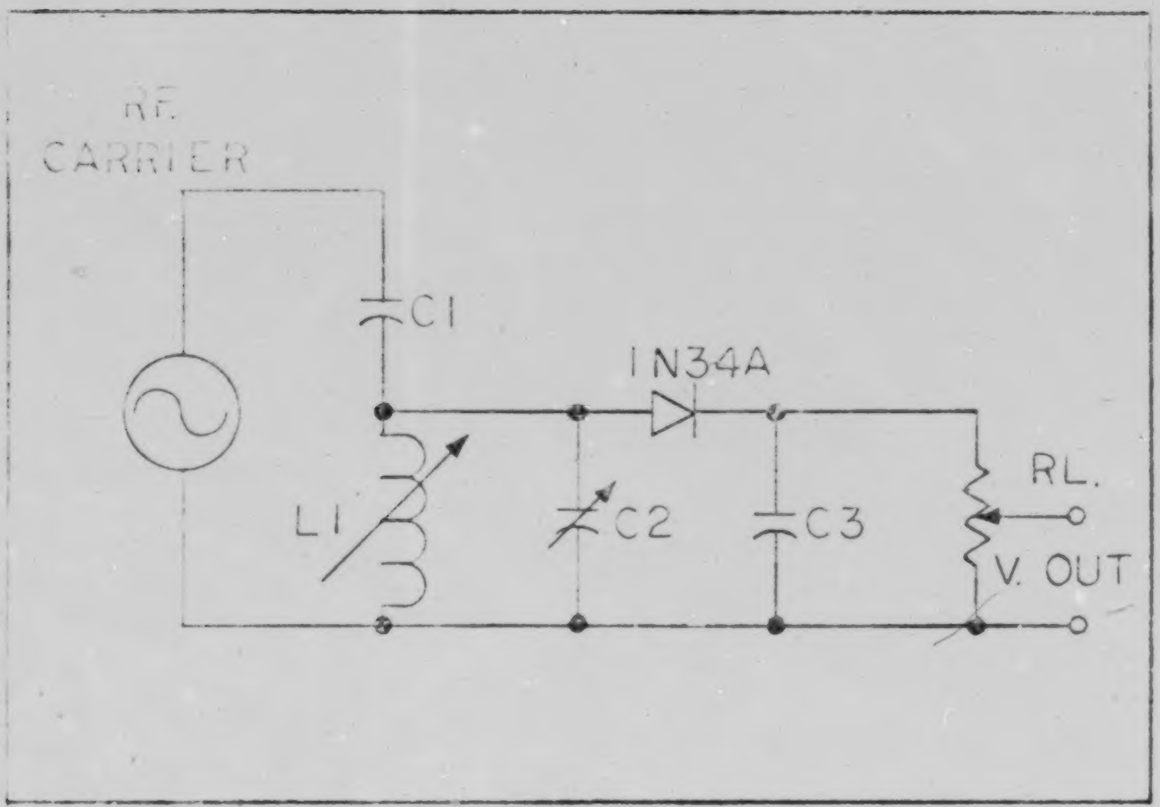
The following general rules were followed while preparing diagrams:

1. All drawings were originally prepared within four and one-half by six and one-half inch spaces with margin lines included in the diagram.
2. The lettering was one-eighth inch, Gothic, vertical lettering with very open, sharp letters so that they could be photo-reduced. All letters which are subscript or superscripts are written in full size letters but down or up one-half a line. All letters are drawn in open form.
3. Drawings are made on vellum paper of standard laboratory or graphic arts quality.
4. Generally, a 2-H pencil was used and very dark lines were produced. The pencil grade is not as important as the darkness of the lines.
5. No shading or half-tones may be used in preparing the drawings.

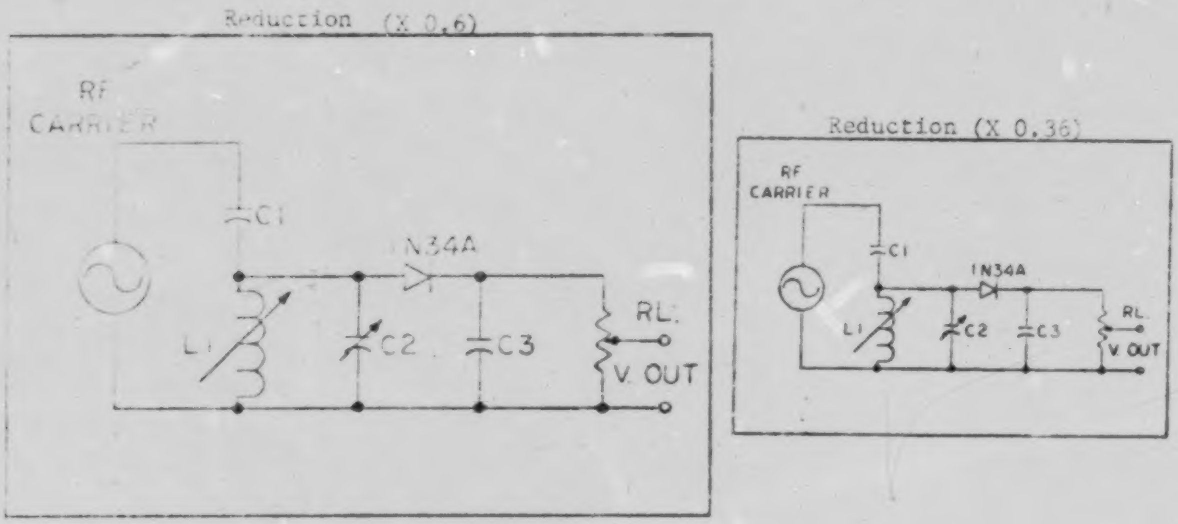
6. No light lines are used, for example, to form the gird for a graph.

7. When axis for graphs are drawn, only notched marks at the inside edge of the graphs are used to define the numerical scale. Light lines are not acceptable.

See Figure 4 for an illustration of a properly drawn diagram and its photo-reduction to final size for the item.


RF
CARRIER
C1
1N34A
L1
C2
C3
RL.
V. OUT

Original Diagram


RF
CARRIER
C1
1N34A
L1
C2
C3
RL.
V. OUT
RF
CARRIER
C1
1N34A
L1
C2
C3
RL.
V. OUT

Reduction (X 0.6)

Reduction (X 0.36)

Figure 4 . An Example of an Original Diagram and the Two Stages in its Reduction.

Item Analysis

The item analysis of the items prepared for electronics has consisted of several different steps. Each step is designed to insure a high quality wording and content of the items and just as important, that the items in fact are careful measures of the specific behavioral objectives defined for electronics. The general procedure for reviewing the items will be described below in some detail and the particular materials developed for this process will be described.

Review by subject matter specialist

After the initial writing of the items, the subject matter specialist reviewed the items for content, accuracy, and close relationship to the objectives. This review of items identified problems in the subject matter of the objectives, the content of items, and the appropriateness of various alternatives for the items. This content review was carried out by two subject matter specialists independently. The review indicated that the quality of the relationships between items and objectives was very close and that the content of the items was entirely appropriate for the measurement of the objectives.

Review by teachers and students

After the initial review by a subject matter specialist, the items were arranged in a booklet form along with their associated behavioral objectives and a short questionnaire. The following page labeled Figure 5, includes one page of the entire booklet. The booklet collected systematically information on the opinions of teachers and students to the appropriateness of the

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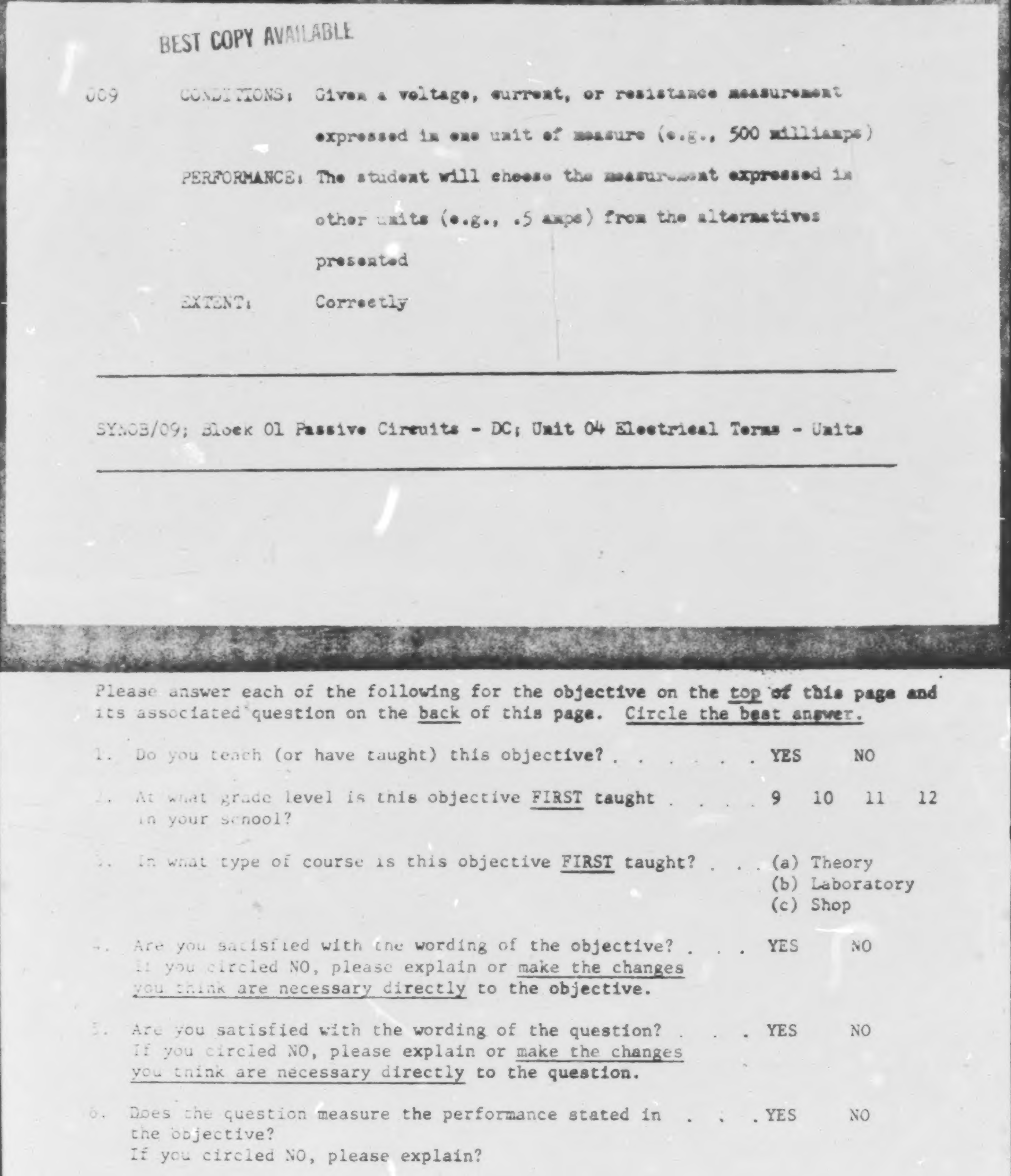

009 CONDITIONS: Given a voltage, current, or resistance measurement expressed in one unit of measure (e.g., 500 milliamps)

PERFORMANCE: The student will choose the measurement expressed in other units (e.g., .5 amps) from the alternatives presented

EXTENT: Correctly

SYNOB/09; Block 01 Passive Circuits - DC; Unit 04 Electrical Terms - Units

---

Please answer each of the following for the objective on the top of this page and its associated question on the back of this page. Circle the best answer.

1. Do you teach (or have taught) this objective? . . . . YES NO

2. At what grade level is this objective FIRST taught in your school? 9 10 11 12

3. In what type of course is this objective FIRST taught? . . . (a) Theory
   (b) Laboratory
   (c) Shop

4. Are you satisfied with the wording of the objective? . . . . YES NO
   If you circled NO, please explain or make the changes you think are necessary directly to the objective.

5. Are you satisfied with the wording of the question? . . . . YES NO
   If you circled NO, please explain or make the changes you think are necessary directly to the question.

6. Does the question measure the performance stated in the objective? . . . YES NO
   If you circled NO, please explain?

Figure 5. Sample Page From Questionnaire Asking Teachers To Critique Objectives and Items.

objective, the appropriateness of the wording of the question, and the relationship of the question to the objective.

Final review

After corrections and suggestions made by the subject matter specialists, teachers and students were collected and considered, a final editing and arrangement of items to achieve maximum consistency of the final set of materials was undertaken. This review and final editing was the responsibility of the authors of this report. The wording of all questions was clarified to answer any questions raised by the earlier reviewers. The diagrams and alternatives were rearranged where such needs were identified. In all cases, the final objectives and items were judged to be very closely related and were considered quality measures of student performance of the specified objectives.

Throughout the process of item analysis, considerations related to the item validity as mentioned by Gorth and Hambleton (1972) have been considered. The difficulties presented by Gorth and Hambleton in their article indicate that standard procedures for item analysis of criterion-referenced items have not yet been developed. The crucial variables identified by these authors are validation of the relationship of items and objectives and the content validity suggested by the review of content matter experts, teachers, and students. All of these issues have been considered in the item analysis results reported here.

A Teacher's Guide to Test Construction

This section describes briefly the use of the item and objective bank in preparing teacher made tests in occupational education. These tests are based upon behavioral objectives and criterion-referenced items. They can be developed directly from the materials provided by the test development project and can be used immediately by teachers. The primary goal of the teacher's guide is to allow local autonomy to teachers in the selection and composition of tests to suit their local needs and purposes. Without the flexibility of item and objective banks, local needs would have to be subjugated to the specifications outlined by the test developers in constructing individual tests.

Purpose of the test

A teacher can define the purpose of the test in a variety of ways. Specifically, the teacher may develop a test to measure individual students' performance on a set of objectives. These objectives may be the set of objectives contained in a unit, in a semester, or in a full year's worth of work. Also the teacher may be concerned with evaluating the effectiveness of some curriculum materials designed to teach particular objectives. This approach would be similar to the Comprehensive Achievement Monitoring (CAM) approach described partially in the article by Gorth and Hambleton (1972). In either case, the teacher has the control over the design of the test initially be deciding what the purpose and focus of the test should be and then by selecting the specific objectives and items which should be associated with the test.

A general procedure to develop tests should follow the steps below.

Procedure for test construction

1. Define the purpose of the test as evaluating individual performance or school curriculum performance.

2. Select the objectives which have been covered by individual pupils or taught by the curriculum during the time period of interest to the teacher.

3. Rank order the objectives by priority. The priority may be the importance of the objective, the hierarchical position of the objective in a sequence of objectives, the amount of time spent in teaching the objective, or the importance of that objective to the students' later success in courses or on the job. The objectives selected should be ranked from the highest to the lowest, from one to the largest number necessary.

4. A specified amount of time should be specified within which the test is to be administered.

5. The questions associated with the objectives selected for the tests should be reviewed. The items for the test should be selected according to the priorities established for their related objectives. Only as many items should be selected for the test as can be answered by all students in the time available for the test.

6. After these items have been selected, the teacher should proceed to develop the test format and scoring key as suggested in the following section.

Duplication of individual tests

The process of preparing the duplication master for the test is very straightforward. It follows directly from the design of the item cards for the item bank. The procedure follows the following steps:

1. Arrange the item cards so that only information to be read by individual students is visible from one item to the next. Only enough items are arranged to complete an 8 1/2 by 11 page of paper with one inch margins around the edges. If an item cannot be completely contained on one page it should be moved to the subsequent page. The item card can be arranged either in the numerical order of their objectives or randomly arranged, or arranged in some other order which is considered convenient by the teacher.

2. After the item cards are arranged in order with only the student instructions showing, one copy of them is Xeroxed.

3. After a single copy of the test questions has been Xeroxed, each page of the test must be properly labeled with the following information:

   a. the school name;

   b. the date;

   c. the test form number;

   d. the page number;

   e. a question position number for each question on the test. For example, the first question on the test should be number 1, the second question, number 2, etc.

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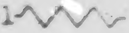
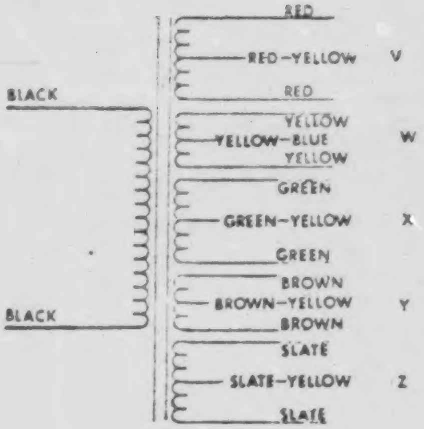
Which of the following components is represented by the symbol  ?

A. Capacitor
B. Fixed resistor
C. Tapped resistor
D. Rheostat
E. Potentiometer

Select from the alternatives given the purpose of winding (V).

A. Filament No. 1
B. Filament No. 2
C. Filament No. 3
D. High Voltage
E. Rectifier Filament


RED
RED-YELLOW
V
RED
BLACK
YELLOW
YELLOW-BLUE
W
YELLOW
GREEN
GREEN-YELLOW
X
GREEN
BROWN
BROWN-YELLOW
Y
BROWN
BLACK
SLATE
SLATE-YELLOW
Z
SLATE

For the circuit to the right the required input voltage V_{in} is

A. 5V
B. 15V
C. 18V
D. 27V
E. 36V

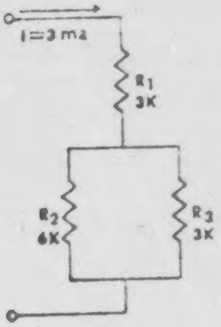

I=3 ma
R1
3K
R2
6K
R3
3K

Figure 6a. Partial Test Form Constructed from Item Cards: (a) Item Cards Xeroxed; (b) Xeroxed Copy of Item Cards Properly Labeled with Heading and Question Positions.

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[illegible]
[illegible] November 8, 1972

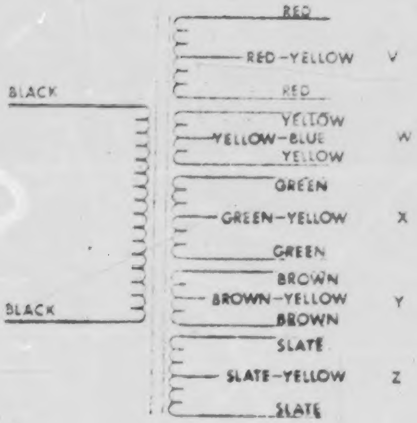
FORM [illegible]
EASTERN REGIONAL TECHNICAL HIGH

Which of the following components is represented by the symbol -/\/\/\- ?

a. Capacitor
b. Fixed resistor
c. Tapped resistor
d. Rheostat
e. Potentiometer

Select from the alternatives given the name of winding (V).

a. Filament No. 1
b. Filament No. 2
c. Filament No. 3
d. High Voltage
e. Rectifier Filament


RED
RED-YELLOW
V
BLACK
RED
YELLOW
YELLOW-BLUE
YELLOW
W
GREEN
GREEN-YELLOW
X
GREEN
BROWN
BROWN-YELLOW
Y
BLACK
BROWN
SLATE
SLATE-YELLOW
Z
SLATE

For the circuit to the right the required input voltage V_{in} is

a. [illegible]
b. [illegible]
c. [illegible]
d. [illegible]
e. 36V

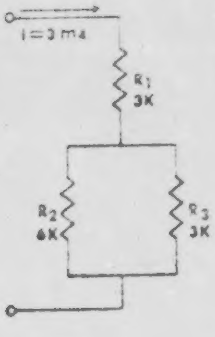

I = 3 mA
R1
3K
R2
6K
R3
3K

Figure [illegible]. Partial Test Form Constructed from Item Cards: (a) Item Cards Xeroxed; (b) Xeroxed Copy of Item Cards Properly Labeled with Heading and Question Positions.

Figure 6 shows the process of going through the steps of Xeroxing the page and labeling the page of individual test items.

4. After each page of the test is properly labeled this page can be transferred by Gestafax process to a mimeograph master or by a photo-process to an offset master before running off the required number of copies of the test.

Answer key

The answer key for criterion-referenced tests includes both the correct answer for each question as well as any directions to teachers necessary to prepare materials which students will need in actually carrying out performance test items. The answer key can be specifically developed so that it includes the correct answer, the unit block, and the objective number measured by the item as well as its permanent item number in the item bank by photo-copying the bottom portion of each item card. In addition, all of the necessary directions to teachers to set up individual test items are also contained at the bottom of the item cards below the row of asterisks. This procedure should be exactly the same as the preparation of the test from the item cards and each item card should be arranged on an 8 1/2 by 11 sheet of paper with one inch margins with just the identification numbers for each item card as well as the teacher directions at the bottom of each item card showing. This page can be Xeroxed once and the teacher can fill in on the Xeroxed copy, probably in pen, the necessary information about test form, date, school, and question position on the test form. This becomes the teacher's answer key providing all available information in each test question. Steps in this procedure are shown in Figure 7.

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Ans.	Block	Unit	Objective	Test Item
2	01	01	003	000301

Ans.	Block	Unit	Objective	Test Item
4	02	08	050	005001

Ans.	Block	Unit	Objective	Test Item
2	01	09	016	001601

Figure 7a. Partial Answer Key for Test (Constructed From Item Cards): (a) Item Cards Xeroxed; and (b) Xeroxed Copy of Item Cards Properly Labeled With Heading and Question Positions.

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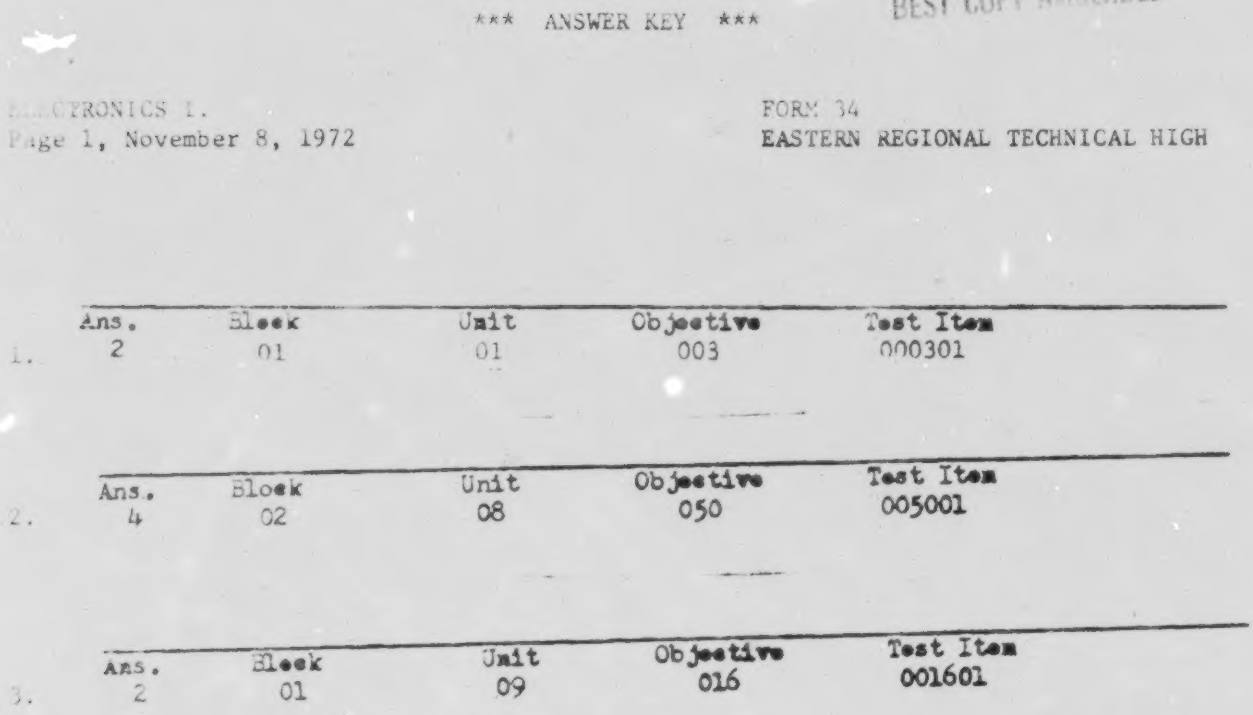

*** ANSWER KEY ***

ELECTRONICS I.
Page 1, November 8, 1972

FORM 34
EASTERN REGIONAL TECHNICAL HIGH

	Ans.	Bleek	Unit	Objective	Test Item
1.	2	01	01	003	000301

	Ans.	Bloek	Unit	Objective	Test Item
2.	4	02	08	050	005001

	Ans.	Bleek	Unit	Objective	Test Item
3.	2	01	09	016	001601

Figure 7b. Partial Answer Key for Test (Constructed From Item Cards): (a) Item Cards Xeroxed; and (b) Xeroxed Copy of Item Cards Properly Labeled With Heading and Question Positions.

Administering the test

The administration of criterion-referenced tests should follow the same procedures that many classroom tests follow. Each student should be given a clean copy of the test with all necessary instructions in answering the test. It is important that every student have adequate time to answer all of the questions on the test. If this is not allowed, then, the test becomes a speeded test which is not appropriate for most criterion-referenced situations (although some criterion-referenced situations require a timing of pupils).

Assigning grades

Grades should be assigned based upon pupil achievement of a fixed number of items on each test form. Students should not be compared with one another, but should be allowed to move on to new activities or promoted to new grade levels based upon the total number of questions which they are able to answer correctly, not how many questions they answer in relation to another pupil. A variety of grading strategies can be developed by individual teachers to suit their local needs.

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Appendix A

2

Proficiency Examinations for Prospective Candidates for Vocational Teacher Program

Prepared By: Wilfrid Savoie

Date: 17 June 1972

Purpose: To aid in the selection of candidates for entrance to the teacher training program for vocational education in Massachusetts.

Background of Prospective Candidates:

Average Age:	35
Average Education:	Associate Degree
Average Experience:	industrial 12 years teaching 2/3 year

Written Exam:

Total Tested: 15

Time Required to Complete: Shortest, 1 hr. 20 min.;
Average, 1 hr. 50 min.;
Longest, 2 hrs. 15 min.

Test Results:
High = 86
Low = 60
Median = 72
Mode = 72
Mean = 73.7

Test Items Used:

000301, 000401, 000801, 000901, 001401, 001501, 001601, 001701, 002701, 004101, 004201, 004601, 004701, 004801, 005201, 005301, 005601, 006401, 007001, 007801, 008001, 007601, 008801, 008201, 008501, 012301, 009001, 009101, 012801, 010201, 012701, 010401, 010101, 010501, 013401, 002201, 012401, 011701, 012101, 013701, 014901, 003701, 005001, 005701, 016201.

Laboratory Exam:

Total Tested: 15

Time Required to Complete: Shortest, 1 hr. 30 min.;
Average, 1 hr. 45 min.;
Largest, 2 hrs. 15 min.

Test Results:
High = 88
Low = 5
Median = 78
Mode = 78
Mean = 62.9

Test Items Used (used in essay form): 006501, 006601, 007101, 006901, 007201.

Appendix B

Sample Computer Output
From An
Objective and Item Bank

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```
.C.                                                   QUES.

19 MICROSCOPE- THE STUDENT WILL KNOW SOME OF THE TYPES OF       11   -0  15
   MICROSCOPES USED IN BIOLOGICAL STUDIES. THE STUDENT WILL      0 THE PRINCIPLE ADVANTAGE OF AN ELECTRON MICROSCOPE OVER THE
   KNOW THE ESSENTIAL PARTS AND PROPER USE OF THE COMPOUND       0 VISIBLE LIGHT MICROSCOPE RESULTS FROM THE
   MICROSCOPE. THE STUDENT WILL KNOW THE PROPER WAY TO USE    *  1 SHORTER WAVE LENGTH OF ELECTRON WAVES AS COMPARED WITH
   PREPARED SLIDES AND HOW TO MAKE SLIDES FROM COLLECTED      *  1 VISIBLE LIGHT WAVES
   MATERIALS.                                                    2 A GREATER PENETRATING POWER OF ELECTRON WAVES AS COMPARED
                                                                 2 WITH VISIBLE LIGHT WAVES
                                                                 3 DIFFERENCES IN SIZE OF THE MICROSCOPE
                                                                 4 SPECIAL ABILITY OF THE ELECTRON MICROSCOPE FOR VIEWING
                                                                 4 LIVING MATERIAL
                                                                 5 ELECTRICAL CHARGE ON THE ELECTRON WAVES

15                                                              12   -0  15
                                                                 0 IF YOU NEEDED MORE LIGHT TO VIEW A SLIDE YOU WOULD USE THE:
                                                              *  1 DIAPHRAGM
                                                                 2 STAGE CLIPS
                                                                 3 OCULAR
                                                                 4 BODY TUBE
                                                                 5 OBJECTIVES

15                                                              13   -0  15
                                                                 0 WHEN YOU BEGIN TO LOOK FOR SOMETHING ON THE SLIDE YOU SET
                                                                 0 THE MICROSCOPE ON THE:
                                                              *  1 LOW POWER OBJECTIVE
                                                                 2 HIGH POWER OBJECTIVE
                                                                 3 OCULAR
                                                                 4 FINE ADJUSTMENT
                                                                 5 COARSE ADJUSTMENT

15                                                              14   -0  15
                                                                 0 YOU MAY REMOVE AIR BUBBLES FROM A WET MOUNT BY:
                                                                 1 TAPPING THE COVER GLASS WITH YOUR FIST
                                                              *  2 TAPPING THE COVER GLASS WITH A PENCILL ERASER
                                                                 3 ADDING MORE WATER
                                                                 4 BY HOLDING THE SLIDE ON AN ANGLE
                                                                 5 PRESSING COVER GLASS WITH YOUR THUMB TO SQUEEZE THEM OUT

15                                                              15   -0  15
                                                                 0 THE TYPE OF MICROSCOPE YOU WILL USE IN CLASS MOST OF THE
                                                                 0 TIME IS THE
                                                                 1 DISSECTING MICROSCOPE
                                                                 2 ELECTRON MICROSCOPE
                                                                 3 HAND MICROSCOPE
                                                                 4 PHASE-CONTRAST MICROSCOPE
                                                              *  5 COMPOUND MICROSCOPE

20 CELL STRUCTURE-THE STUDENT SHOULD BE ABLE TO ANSWER          16   -0  20
   QUESTIONS THAT WOULD BE RELATED TO ONLY A PLANT OR ANIMAL     0 MOST PLANTS CELLS CAN MAKE THEIR OWN FOOD. THIS IS POSSIBLE
   CELL OR BOTH BY KNOWING THE STRUCTURES AND CELL CONTENTS OF   0 BECAUSE OF
   BOTH PLANT AND ANIMAL CELLS.                               *  1 CHLOROPHYLL
                                                                 2 CELL WALLS
                                                                 3 MITOCHONDRIA
                                                                 4 ASTERS
                                                                 5 THE NUCLEUS
```

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QUESTION 1 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF THE BATTLE OF THE MARNE, SEPTEMBER, 1914.

A. AN ACCOUNT COMPILED FROM MATERIAL TAKEN FROM REPORTS OF OPPOSING COMMANDERS.
B. AN ACCOUNT APPEARING IN A JOURNAL PRINTED IN A NEUTRAL COUNTRY.
C. AN ACCOUNT WHICH CONTRASTED THE SPIRIT OF THE HEROIC BOYS OF THE ALLIES AND THE PONDEROUS FOOLHARDINESS OF THE ENEMY.

QUESTION 2 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF THE PROBLEMS FACING HIGH SCHOOL DROPOUTS.

A. A PUBLICATION BY THE U. S. DEPARTMENT OF LABOR ON THE LIMITED JOB OPPORTUNITIES AVAILABLE TO DROPOUTS.
B. A TV DOCUMENTARY ON SCHOOL DROPOUTS IN WHICH TEN DROPOUTS ARE INTERVIEWED.
C. AN ARTICLE ON THE PROBLEMS A DROPOUT MUST FACE IN SCHOOL AND SOCIETY MAGAZINE WRITTEN BY A FAMOUS SOCIOLOGIST.

QUESTION 3 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF DWIGHT D. EISENHOWSER AS A GENERAL.

A. A U. S. ARMY HISTORIAN#S ACCOUNT OF EISENHOWER#S MILITARY CAREER.
B. A MOVIE DEPICTING THE LIFE OF GENERAL EISENHOWER.
C. AN ACCOUNT WRITTEN BY HIS WIFE, MAMIE, ABOUT THEIR YEARS TOGETHER.

QUESTION 4 --
WOULD YOU CLASSIFY THE FOLLOWING ITEM AS A SOURCE OR A SECONDARY ACCOUNT FOR THE EVENT IT DESCRIBES.
A PHOTOGRAPH OF THE BURNING OF THE AIRSHIP HINDENBURG.

A. SECONDARY ACCOUNT.
B. SOURCE.

QUESTION 5 --
WOULD YOU CLASSIFY THE FOLLOWING ITEM AS A SOURCE OR A SECONDARY ACCOUNT FOR THE EVENT IT DESCRIBES.
A PAPYRUS ROLL USED BY THE EGYPTIANS.

A. SECONDARY ACCOUNT.

[illegible]

QUESTION 1 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF THE BATTLE OF THE MARNE, SEPTEMBER, 1914.

A. AN ACCOUNT COMPILED FROM MATERIAL TAKEN FROM REPORTS OF OPPOSING COMMANDERS.
B. AN ACCOUNT APPEARING IN A JOURNAL PRINTED IN A NEUTRAL COUNTRY.
C. AN ACCOUNT WHICH CONTRASTED THE SPIRIT OF THE HEROIC BOYS OF THE ALLIES AND THE PONDEROUS FOOLHARDINESS OF THE ENEMY.

QUESTION 2 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF THE PROBLEMS FACING HIGH SCHOOL DROPOUTS.

A. A PUBLICATION BY THE U. S. DEPARTMENT OF LABOR ON THE LIMITED JOB OPPORTUNITIES AVAILABLE TO DROPOUTS.
B. A TV DOCUMENTARY ON SCHOOL DROPOUTS IN WHICH TEN DROPOUTS ARE INTERVIEWED.
C. AN ARTICLE ON THE PROBLEMS A DROPOUT MUST FACE IN SCHOOL AND SOCIETY MAGAZINE WRITTEN BY A FAMOUS SOCIOLOGIST.

QUESTION 3 --
WHICH OF THE FOLLOWING MATERIALS OR SOURCES WOULD YOU CONSIDER MOST RELIABLE TO GIVE A TRUE PICTURE OF DWIGHT D. EISENHOWSER AS A GENERAL.

A. A U. S. ARMY HISTORIAN#S ACCOUNT OF EISENHOWER#S MILITARY CAREER.
B. A MOVIE DEPICTING THE LIFE OF GENERAL EISENHOWER.
C. AN ACCOUNT WRITTEN BY HIS WIFE, MAMIE, ABOUT THEIR YEARS TOGETHER.

QUESTION 4 --
WOULD YOU CLASSIFY THE FOLLOWING ITEM AS A SOURCE OR A SECONDARY ACCOUNT FOR THE EVENT IT DESCRIBES.
A PHOTOGRAPH OF THE BURNING OF THE AIRSHIP HINDENBURG.

A. SECONDARY ACCOUNT.
B. SOURCE.

QUESTION 5 --
WOULD YOU CLASSIFY THE FOLLOWING ITEM AS A SOURCE OR A SECONDARY ACCOUNT FOR THE EVENT IT DESCRIBES.
A PAPYRUS ROLL USED BY THE EGYPTIANS.

A. SECONDARY ACCOUNT.

OBJECTIVES

BOOKLET

CRITERION-REFERENCED ITEM BANKING
IN ELECTRONICS

by

William Phillip Gorth

and

Hariharan Swaminathan

Center for Educational Research
School of Education
University of Massachusetts
June 1, 1972

001 CONDITIONS: Given either a resistor or an actual-size picture of a carbon resistor with the colors

PERFORMANCE: The student will choose either the resistor value, the tolerance, or wattage from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 1	0 0 0 1

---

003 CONDITIONS: Given the name of an electronic component, e.g., resistors, transformers, switches

PERFORMANCE: The student will choose the correct symbol from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 1	0 0 0 3

004 CONDITIONS: Given a diagram of the structure of an atom with its parts lettered

PERFORMANCE: The student will choose the letter associated with the name of a part requested

EXTENT: Percent

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 2	0 0 0 4

008 CONDITIONS: Given a 10 inch slide rule and two 3 digit numbers

PERFORMANCE: The student will find the product of the numbers from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 4	0 0 0 8

009 CONDITIONS: Given a voltage, current, or resistance measurement expressed in one unit of measure (e.g., 500 milliamps)

PERFORMANCE: The student will choose the measurement expressed in other units (e.g., .5 amps) from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 4	0 0 0 9

---

012 CONDITIONS: Given three identical dry cells, hook-up wire, and a VOM

PERFORMANCE: The student will construct the series-parallel circuit, determine the total output voltage and choose the value from a list of alternatives presented

EXTENT: Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 5	0 0 1 2

013 CONDITIONS: Given a power source, a series-parallel schematic diagram, hook-up wire, three resistors and a VOM

PERFORMANCE: The student will construct the series-parallel circuit and will choose from a set of alternatives the current and voltage of a specified resistor of the constructed circuit

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 6 0 0 0 7 0 0 0 8	0 0 1 3

014 CONDITIONS: Given a three-resistor voltage divider circuit diagram showing the supply voltage and the value of each resistor

PERFORMANCE: The student will choose the specified voltage from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 6 0 0 0 8	0 0 1 4

015 CONDITIONS: Given a circuit diagram of a linear resistive network with 2 voltage sources and 3 resistors

PERFORMANCE: The student will find Thevinin's equivalent voltage and resistance from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 8	0 0 1 5

016 CONDITIONS: Given a diagram of a series-parallel circuit with the minimum current, voltage, resistor values indicated, and the others not indicated but lettered

PERFORMANCE: The student will choose the value of a lettered either voltage, current, or resistance from the alternatives presented

EXTENT: Calculation to 3 significant figures out of 10 correct answers

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 0 9	0 0 1 6

017	CONDITIONS:	Given the circuit diagram of three resistors connected in series-parallel and the current
	PERFORMANCE:	The student will choose the total power consumed from a list of alternatives presented
	EXTENT:	Correct to three places

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 1 0	0 0 1 7

022	CONDITIONS:	Given a picture of a bar magnet or horseshoe magnet and 5 diagrams of fields of force with one correct for the magnet
	PERFORMANCE:	The student will identify the correct field of force from the alternatives presented
	EXTENT:	Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 1 4	0 0 2 2

026 **CONDITIONS:** Given a circuit diagram of three inductors connected in series-parallel

PERFORMANCE: The student will choose the total inductance of the circuit from a list of alternatives presented

EXTENT: Correctly to three places

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 1 6	0 0 2 6

033 **CONDITIONS:** Given an impedance bridge and a length of resistance wire

PERFORMANCE: The student will measure and choose the resistance from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 0	0 0 3 3

034	CONDITIONS:	Given the specifications of a motor movement
	PERFORMANCE:	The student will choose the design of the appropriate meter shunt and the multiplier resistors from the alternatives presented
	EXTENT:	With tolerance of the components and test equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 0	0 0 3 4

035	CONDITIONS:	Given a general purpose bridge and a capacitor
	PERFORMANCE:	The student will determine the capacitance and choose the value from a set of alternatives presented
	EXTENT:	Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 1	0 0 3 5

036 **CONDITIONS:** Given a VOM without batteries, batteries for the VOM, and a resistor of unknown resistance

PERFORMANCE: The student will replace batteries in VOM and measure the resistance and choose the value from the alternatives presented

EXTENT: Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 1	0 0 3 6

037 **CONDITIONS:** Given a VOM's operational manual or part of a manual

PERFORMANCE: The student will choose the statement of the precautions to be observed when making either a voltage, current, or resistance measurement from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 1	0 0 3 7

039 CONDITIONS: Given a picture of a power supply with its controls lettered and its instructional manual

PERFORMANCE: The student will choose the letter of the control for the function specified from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 1	0 0 3 9

040 CONDITIONS: Given a capacitor tester and a capacitor.

PERFORMANCE: The student will choose whether the capacitor is good, open, shorted or leaky

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 1	0 0 2 1	0 0 4 0

041 CONDITIONS: Given either the period of an AC wave or the frequency

PERFORMANCE: The student will calculate and choose from the alternatives presented either (a) the frequency or (b) the period

EXTENT: Correctly to three places

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 1	0 0 4 1

042 CONDITIONS: Given the diagram of an AC waveform

PERFORMANCE: The student will choose the name of the waveform from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 1	0 0 4 2

046 CONDITIONS: Given a series RL schematic diagram showing the applied voltage, the frequency, and the value of the components

PERFORMANCE: The student will choose the phase relationship between the applied voltage and the voltage across the components from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 4	0 0 4 6

---

047 CONDITIONS: Given the value of the inductance but without the formula

PERFORMANCE: The student will choose the inductive reactance from a set of alternatives presented

EXTENT: Correct to three places

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 5	0 0 4 7

048 CONDITIONS: Given a parallel, R.L. & C. circuit (all combinations)

PERFORMANCE: The student will choose the impedance and phase angle of the network from the alternatives presented

EXTENT: Percent

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 6	0 0 4 8

050 CONDITIONS: Given a power transformer schematic which shows the color coded wires of each winding

PERFORMANCE: The student will specify the purpose of each winding from the alternatives presented

EXTENT: Percent

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 8	0 0 5 0

052 **CONDITIONS:** Given a parallel RC circuit, the voltage applied, the frequency, and the value of the components

PERFORMANCE: The student will choose from the list of alternatives the phase relationship between voltage applied and the voltage across the components

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 9 0 0 1 0 0 0 1 1	0 0 5 2

---

053 **CONDITIONS:** Given a diagram of three capacitors in series with the value of each capacitor labeled and with the voltage applied labeled

PERFORMANCE: The student will choose the voltage drops across the capacitors from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 0 9	0 0 5 3

054 CONDITIONS: Given a series RLC circuit, a signal generator, and an oscilloscope

PERFORMANCE: The student will determine the resonant frequency and choose the value from a list of alternatives presented

EXTENT: Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 1 2	0 0 5 4

055 CONDITIONS: Given the frequency response of a low pass filter

PERFORMANCE: The student will choose from a list of pairs of resistor and inductor values the pair which will give the desired frequency response

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 1 3	0 0 5 5

056 CONDITIONS: Given an RC circuit and the values of the components

PERFORMANCE: The student will choose from the alternatives presented the time constant of the circuit

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 1 4	0 0 5 6

057 CONDITIONS: Given a picture of the face of an oscilloscope (single or dual trace) with each control lettered and part of the instruction manual

PERFORMANCE: The student will choose the control by letter for the function requested

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 2	0 0 1 5	0 0 5 7

058 CONDITIONS: Given a variable power supply, VOM, tube manual, vacuum tube diode, and load resistor

PERFORMANCE: The student will choose the plot of plate current with changing plate voltages from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 1	0 0 5 8

059 CONDITIONS: Given a VOM and a transistor

PERFORMANCE: The student will determine if the transistor is an NPN or PNP type and choose from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 1	0 0 5 9

060 CONDITIONS: Given a variable regulated power supply, a resistor, a diode, a VOM

PERFORMANCE: The student will choose from the alternatives presented the current voltage characteristic curve of the diode

EXTENT: Correctly to the tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 1	0 0 6 0

061 CONDITIONS: Given two DC power supplies, a VTVM, two resistors and a transistor

PERFORMANCE: The student will determine the plot of the common emitter output characteristic curve and choose plot from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 1	0 0 6 1

063 CONDITIONS: Given the identification number of one tube, (using the number and letter system)

PERFORMANCE: The student will choose the tube's type, purpose and heater voltage from the alternatives presented

EXTENT: Percent

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 1	0 0 6 3

064 CONDITIONS: Given a sketch of the atomic makeup of either N-type or P-type semiconductor material

PERFORMANCE: The student will identify each element, e.g., electrons, holes, donor atoms, acceptor atoms, ions, etc., from the alternatives presented

EXTENT: Percent

BLOCK	UNIT	OBJECTIVE
[illegible]	0 0 0 1	0 0 6 4

CONDITIONS:	Given the output waveform of a transistor amplifier and the ambient temperature at which the amplifier is operating
PERFORMANCE:	The student will choose from the alternatives presented the output waveform which would occur at another temperature
EXTENT:	Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 6 5

CONDITIONS:	Given a common emitter amplifier, an oscilloscope, and signal generator
PERFORMANCE:	The student will determine either the input and output voltage, phase, or impedance (input and output) and choose the value from the alternatives presented
EXTENT:	Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 6 6

067 CONDITIONS: Given a class A triode audio amplifier, three different specified DC load resistors and a VTVM

PERFORMANCE: The student will select from the alternatives presented the operating point (I/V) for each load resistor

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 6 7

---

069 CONDITIONS: Given a common emitter amplifier, a signal generator, and an oscilloscope

PERFORMANCE: The student will determine the frequency response of the amplifier and choose the plot from a set of alternatives presented

EXTENT: Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 6 9

070 CONDITIONS: Given the schematics of one of the following amplifier configurations: common base, common emitter, common collector, triode conventional amp, grounded grid, or cathode follower

PERFORMANCE: The student will choose its name from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 7 0

071 CONDITIONS: Given a common emitter transistor amplifier operating under an improper condition, a VOM, an oscilloscope, and a signal generator

PERFORMANCE: The student will choose from the alternatives presented the output waveform obtained under the improper conditions

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 7 1

072 CONDITIONS: Given an RC, coupled two-stage amplifier, oscilloscope, signal generator and a VTVM

PERFORMANCE: The student will measure the voltage gain and choose the value from a set of alternatives presented

EXTENT: Tolerance of equipment

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 7 2

---

073 CONDITIONS: Given a conventional vacuum tube push-pull amplifier, VTVM, oscilloscope, and signal generator

PERFORMANCE: The student will measure the DC and AC imbalance in the plate and choose from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 7 3

074 CONDITIONS: Given a circuit diagram of an RC coupled triode tube amplifier terminated by a DC load resistor and using grid leak biasing

PERFORMANCE: The student will choose the Thevenin's Equivalent circuit from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 2	0 0 7 4

---

076 CONDITIONS: Given the schematic diagram of a transistor oscillator circuit

PERFORMANCE: The student will choose its basic operation from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 3	0 0 7 6

077	CONDITIONS:	Given an audio oscillator, scope, frequency standard, schematic diagram, and specifications
	PERFORMANCE:	The student will determine the frequency of the oscillator (using Lissajous figures) and choose the value from a set of alternatives presented
	EXTENT:	Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 3	0 0 7 7

078	CONDITIONS:	Given the schematic diagram of one of several solid state oscillators (Hartley, Collpitts, Crystal, Armstrong, Phase Shift, Wein Bridge)
	PERFORMANCE:	The student will identify its name from the alternatives presented
	EXTENT:	Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 3	0 0 7 8

080 CONDITIONS: Given an explanation of the operation of a detector circuit

PERFORMANCE: The student will choose from the alternatives presented the name of the detector circuit

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 4	0 0 8 0

081 CONDITIONS: Given an operating diode detector circuit, an AM signal generator, and a VOM

PERFORMANCE: The student will choose the DC voltages produced by the AM signal from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 4	0 0 8 1

082 **CONDITIONS:** Given a schematic diagram of one of the following: power supplies, halfwave, full wave, bridge, doublers, gas type, multiphase rectifiers

PERFORMANCE: The student will choose the appropriate name of the power supply from a set of alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 5	0 0 8 2

083 **CONDITIONS:** Given a power supply, a series resistor, Zener diode voltage regulator, a load resistor, and a VOM

PERFORMANCE: The student will identify the graph of the regulated output voltage vs. variations in power supply output voltage and choose from the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 5	0 0 8 3

084 CONDITIONS: Given a full wave rectifier, a VOM, an oscilloscope, and an RC filter

PERFORMANCE: The student will determine the waveform with and without the filter and choose the appropriate waveform from a list of alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 5	0 0 8 4

---

085 CONDITIONS: Given the specifications for the voltage supplied, the desired bleeder current, and the desired divided voltages

PERFORMANCE: The student will choose from the alternatives presented the values of the resistors necessary to produce the desired divided voltages

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 5	0 0 8 5

086 CONDITIONS: Given an operating full wave rectifier (transistor), a VOM, oscilloscope, resistors

PERFORMANCE: The student will determine either the output voltage, ripple voltage, ripple factor, or percentage regulation under no load and choose the value from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0003	0005	0086

---

087 CONDITIONS: Given diodes, resistors, power supply, signal generator, scope, series limiter circuit, and specified input signal

PERFORMANCE: The student will determine its output waveform and choose from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0003	0006	0087

BEST COPY AVAILABLE

088 CONDITIONS: Given an operating solid state free-running collector coupled multivibrator, (Lab model with schematic diagram which has each component lettered), oscilloscope, and a properly labeled diagram of a voltage waveform

PERFORMANCE: The student will select from the alternatives presented the component whose voltage waveform is represented by the diagram

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 3	0 0 0 6	0 0 8 8

[illegible] [illegible] G[illegible] an oscillo[illegible] [illegible] pulse ge[illegible] a power supply and the input wave sp[illegible]

[illegible] The [illegible] from the [illegible] pr[illegible] waveform

[illegible]

[illegible]	UNIT	[illegible]
	0 0 0 [illegible]	

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CONDITIONS: Given a positive voltage square wave [illegible] and an RC [illegible].

PERFORMANCE: The student will calculate the voltage waves across the resistor and capacitor and select the value from a list of alternatives presented.

EXTENT: Correct to three places

[illegible]	UNIT	OBJECTIVE
5	0 0 0 8	0 1 2

CONDITIONS: Given a diagram of a practical [illegible] trapezoidal wave with rise and fall time, [illegible] [illegible], frequency, duty cycle, and average [illegible] indicated [illegible].

PERFORMANCE: The student will choose the characteristics from the alternatives presented.

EXTENT: Correctly

	UNIT	
	1 0	

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[illegible] Given a [illegible] collector [illegible]
[illegible] at [illegible] temperature

[illegible] The student will measure the [illegible]
transistor and choose the value [illegible]
alternatives provided

Tolerance [illegible] percent

UNIT

0

[illegible] Given an [illegible] supplied [illegible] and a load resistor

PERFORMANCE II: The student will measure the operating [illegible]
the [illegible] and choose [illegible]
list of alternatives provided

CRITERIA: Tolerance [illegible] percent

UNIT

0

BEST COPY AVAILABLE

097 CONDITIONS: Given a cathode ray tube number and power supply voltage

PERFORMANCE: The student will determine the range of voltages applied to the deflection plates pin 7 and 10 of a [illegible] C.R.T.

EXTENT: 100% accurate

BLOCK	UNIT	OBJECTIVE
0 0 3 3	0 0 0 [illegible]	2 [illegible]

098 CONDITIONS: Given a problem on picture tube testing

PERFORMANCE: The student will define what it means to rejuvenate, short/open test, and CUT-OFF/[illegible] test

EXTENT: 100% accurate

[illegible]	UNIT	[illegible]
[illegible]	0 0 [illegible]	[illegible]

BEST COPY AVAILABLE

[illegible] [illegible]: [illegible] AC voltage on a DC reference [illegible]

PERFORMANCE: The student will determine the [illegible] [illegible], the amplitude of the AC and DC component of [illegible] and choose from the alternatives presented

CRITERIA: Equipment tolerance

UNIT

S.O.

[illegible] CONDITIONS: Given a pulse generator and an oscilloscope (e.g., Tektronix, Model 535A)

PERFORMANCE: The student will determine either the pulse duration, the rise and fall time, or the repetition rate and choose the value from a set of alternatives presented

CRITERIA: Tolerance of equipment

UNIT

S.O.

BEST COPY AVAILABLE

101 CONDITIONS: Given the [illegible] diagram of a receiver [illegible]

PERFORMANCE: The student will select from the list of [illegible] appropriate function

EXTENT: Correctly

[illegible]	UNIT	OBJECTIVE
	0 0 1	0 [illegible] 5

102 CONDITIONS: Given a frequency range

PERFORMANCE: The student will choose the band, i.e., VLF, LF, MF, HF, VHF, of the spectrum it occupies from the alternatives presented

EXTENT: Percent

[illegible]	UNIT	OBJECTIVE
1	0 0 0 1	0 1 0

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given an inoperative FM receiver (constructed on a modular type chassis system with plug-ins), a VTVM, schematic diagram (to include waveforms and [illegible] measurements) and an oscilloscope

PERFORMANCE: The student will identify from a list of [illegible] presented the faulty component

EXTENT: Correctly

UNIT

[illegible] CONDITIONS: Given a block diagram of an AM transmitter with [illegible] block [illegible]ed

PERFORMANCE: The student will choose the block which [illegible] the specified function from the alternatives presented

Correctly

UNIT

SECT

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[illegible] Given a definition of a type of [illegible],

[illegible] The student will identify the name of the type [illegible]
from the alternatives presented

[illegible] Correctly

	UNIT	[illegible]
4	2	5

[illegible] Given an inoperative [illegible] transmitter [illegible]
modular type chassis system with compon[illegible]
[illegible] V,VM, oscilloscope and schematic diagram [illegible]
waveforms and [illegible] measurements

[illegible] The student will choose from the [illegible]
[illegible] of the faulty component

[illegible] equipment

	UNIT	
	0 0	

BEST COPY AVAILABLE

107 CONDITIONS: Given a piezoelectric transducer. [illegible]

PERFORMANCE: The student will determine the [illegible] voltage [illegible] vs. frequency (audio range) and choose [illegible] the alternatives presented

EXTENT: Equipment tolerance

BLOCK	UNIT	OBJECTIVE
0 [illegible] 4	0 0 0 3	0 [illegible] 7

---

110 CONDITIONS: Given a symptom of a faulty television receiver

PERFORMANCE: The student will select a probable cause from a list of alternatives presented

EXTENT: Correctly

[illegible]	UNIT	[illegible]
0 0 0 4	0 0 0 3	0 [illegible] 1

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given a schema[illegible] [illegible] yoke

PERFORMANCE: The student will determine the [illegible]
tester and the conditions [illegible]

EXTENT: 100% accurate

BLOCK	UNIT	OBJECTIVE
[illegible]	0 0 0 5	0 1 [illegible]

---

112 CONDITIONS: Given a picture tube for a television

PERFORMANCE: The student will list the dangers and precautions
involved when replacing a picture tube

EXTENT: 100% accurate

BLOCK	UNIT	OBJECTIVE
0 0 0 4	0 0 0 5	0 1 1 2

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given a two-digit decimal number between [illegible]

PERFORMANCE: The student will choose its binary equivalent [illegible]
the alternatives presented

CRITERIA: Correctly

[illegible]	UNIT	[illegible]
[illegible] 4	0 0 1 [illegible]	[illegible]

[illegible] CONDITIONS: Given an expression of three 4-bit binary numbers [illegible]
addition and subtraction operations

PERFORMANCE: The student will simplify the expression and [illegible] the
value from the list of alternatives presented

CRITERIA: Correctly

[illegible]	UNIT	[illegible]
0 0 0 4	0 0 1 0	0 1 1 8

BEST COPY AVAILABLE

119 CONDITIONS: Given a word of five, 6-bit binary characters

PERFORMANCE: The student will choose from a list of alternatives presented the parity bits to produce even horizontal and odd vertical parity

[illegible]: Correctly

	UNIT	[illegible]
[illegible] 4	0 0 [illegible] 0	0 [illegible] 9

120 CONDITIONS: Given an unsimplified Boolean algebraic equation in 4 variables

PERFORMANCE: The student will choose from a list of alternatives presented the simplified version of the equation

[illegible]: Correctly

	UNIT	[illegible]
4	0 0 1 0	0 1 2 0

BEST COPY AVAILABLE

121. CONDITIONS: Given a logic circuit (e.g., AND, OR, NAND, NOR)

PERFORMANCE: The student will identify the truth table for the given circuit from the list of alternatives presented

EXTENT: Correctly

CK	UNIT	[illegible]
0 0 0 4	0 0 1 0	0 1 2 1

---

122. CONDITIONS: Given a circuit diagram of a Schmitt Trigger circuit

PERFORMANCE: The student will choose an explanation of the theory of its operation from the alternatives presented

EXTENT: Correctly

CK	UNIT	[illegible]
0 0 0 4	0 0 1 0	0 1 2 2

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given an operating monostable multivibrator, [illegible] pulse generator, and oscilloscope

PERFORMANCE: The student will measure and choose input and output voltage waveforms of the monostable multivibrator [illegible] the alternatives presented

EXTENT: Equipment tolerance

[illegible]	UNIT	[illegible]
[illegible] 0 4	0 0 . 0	0 1 . [illegible]

124 CONDITIONS: Given a 2421 modified decade counter truth table

PERFORMANCE: The student will choose from a list of [illegible] presented the "AND" - gate circuit to [illegible] decimal

EXTENT: Correctly

[illegible]	UNIT	[illegible]
0 0 0 4	0 0 . 0	0 1 . 4

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given a 4 stage 8421 decade counter truth table

PERFORMANCE: The student will choose from a list of alternatives presented the decade counter

EXTENT: Correctly

	UNIT	
[illegible]	0 0 1 0	0 1 [illegible]

[illegible] CONDITIONS: Given a circuit diagram of an excess-3 adder with [illegible] logic function lettered

PERFORMANCE: The student will choose the theory of [illegible] the alternatives presented

EXTENT: Correctly

[illegible]	0 0 [illegible]	1 2

BEST COPY AVAILABLE

127. CONDITIONS: Given a description of the theory of operation of an antenna, e.g., dipole, Marconi, or Hertz

PERFORMANCE: The student will choose the name of the antenna from the alternatives presented

EXTENT: Correctly

	UNIT	SEG
	0 0 [illegible] 6	
[illegible]	0 0 [illegible]	[illegible]

---

128. CONDITIONS: Given a dipole antenna coaxial transmission line and a grid-dip meter

PERFORMANCE: The student will choose the center operating frequency of the antenna from the alternatives presented

EXTENT: [illegible] percent tolerance

	UNIT	
	0 0 [illegible]	[illegible]

BEST COPY AVAILABLE

[illegible] Given a resonant tank circuit and grid-dip oscillator

[illegible] The student will choose from a list of alternatives presented the resonant frequency of the tank

[illegible] Correctly

[illegible]

UNIT
0 0 1 7

[illegible]

[illegible] Given a crystal controlled oscillator and a frequency counter

[illegible] The student will measure the crystal frequency and [illegible] the correct value from the alternatives presented

[illegible] Tolerance of equipment

[illegible]

UNIT
0 0 1 7

[illegible]

BEST COPY AVAILABLE

CONDITIONS: Given a power amplifier and a calibrated [illegible]

PERFORMANCE: The student will measure the power output and [illegible] the value from the alternatives presented.

EXTENT: Tolerance of equipment

[illegible]	UNIT	OBJECTIVE
0 [illegible] 4	0 0 [illegible]	0 1 3 1

CONDITIONS: Given a description of the theory of operation of a communications system, e.g. radar, sonar [illegible]

PERFORMANCE: The student will choose the name of the system from the alternatives presented

EXTENT: Correctly

[illegible]	UNIT	OBJECTIVE
0 0 0 4	0 0 1 9	0 1 3 4

BEST COPY AVAILABLE

CONDITIONS: Given a soldering iron, solder, the basic electronic tools, a wire lug, and insulated wire

PERFORMANCE: The student will solder wire to lug

EXTENT: Industrial standards

	UNIT	
	0 0 [illegible]	

---

137 CONDITIONS: Given a job function which may be performed by the basic electronic hand tools

PERFORMANCE: The student will identify the name of the [illegible] appropriate for the job function from the alternatives [illegible]

EXTENT: Correctly

JOB	UNIT	OBJECTIVE
[illegible] 0 - 5	0 0 0 [illegible]	0 1 3 7

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given a 5 inch length of insulated wire with end stripped, a micrometer, and an AWG wire table

PERFORMANCE: The student will determine the AWG size of the sample and choose from the alternatives presented

EXTENT: Percent

	UNIT	[illegible]
0 2 0 5	0 0 [illegible]	[illegible] 3 5

[illegible] CONDITIONS: Given drill and thread gauge and a machine screw

PERFORMANCE: The student will choose the gauge (and thread size) of the screw from the alternatives presented

EXTENT: Correctly

	UNIT	[illegible]
[illegible]	0 0 0 2	0 [illegible]

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given a [illegible] inch, 1/4 inch piece of aluminum stock, a 12 inch adjustable square, an electric drill, drill bits, tap wrench and taps, and a layout diagram specifying a hole to be drilled and tapped.

PERFORMANCE: The student will drill and tap a hole

EXTENT: Plus or minus one-sixteenth of an inch

BLOCK	UNIT	OBJECTIVE
0 0 0 5	0 0 0 2	0 1 . 0

---

142 CONDITIONS: Given a schematic diagram, components, grid paper, sheet of mylar, PC layout tape, cutting knife

PERFORMANCE: The student will lay out and tape the circuit

EXTENT: Industrial standards

	UNIT	OBJECTIVE
	[illegible] 0 0 1	[illegible]

BEST COPY AVAILABLE

[illegible] CONDITIONS: Given shielded microphone cable, [illegible], a soldering iron, solder, and the basic electronic [illegible]

PERFORMANCE: The student will solder the cable to the connector

EXTENT: Industrial standards

[illegible]	UNIT	OBJECTIVE
[illegible] 0 5	0 0 0 5	0 1 4 4

145 CONDITIONS: Given a schematic diagram consisting of 15-20 components, mounting ("vector") board 5" x 7" push-in terminals ("Flea-clips") and hand tools

PERFORMANCE: The student will construct the circuit

EXTENT: Industrial standards which include minimum lead length and horizontal and vertical positioning of components

[illegible]	UNIT	OBJECTIVE
[illegible]	0 0 0 5	0 1 4 5

BEST COPY AVAILABLE

146 CONDITIONS: Given the dimensions and current requirements [illegible] cable of ten conductors

PERFORMANCE: The student will select the wire and [illegible] and [illegible] a cable harness

EXTENT: Industrial standards

[illegible]

UNIT 0 0 6

[illegible] 0 1 4 6

---

149 CONDITIONS: Given shop tools such as a soldering iron, a drill press, or a pair of diagonal plyers

PERFORMANCE: The student will identify and choose from the alternatives presented the most important safety rule associated with the tool

EXTENT: Correctly

BLOCK 0 0 0 5

UNIT 0 0 0 9

OBJECTIVE 0 1 4 9

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150 CONDITIONS: Given the specifications (which include the manufacturer) of a component and an electronic engineering master

PERFORMANCE: The student will choose from the alternatives presented the price, the part number, and the distributor

EXTENT: Correctly

[illegible]	UNIT	OBJECTIVE
0 [illegible] 5	0 0 0 9	0 1 5 0

---

153 CONDITIONS: Given a 20 x 15 inch piece of #18 gauge sheet aluminum, a hand brake, corner notcher, shearer, and a drawing of a mini-box type chassis

PERFORMANCE: The student will construct a mini-box type chassis

EXTENT: Percent tolerance plus or minus one-sixteenth of an inch

[illegible]	UNIT	OBJECTIVE
[illegible] 5	0 0 1 0	0 1 5 3

154. CONDITIONS: Given an aluminum unpainted chassis complete with all designated cuts and holes and a chassis drawing

PERFORMANCE: The student will paint the chassis

EXTENT: So that paint is smooth and run freeing

BLOCK	UNIT	OBJECTIVE
0 2 0 5	0 0 1 0	0 1 5 4

155 CONDITIONS: Given a panel layout, panel, components, tools

PERFORMANCE: The student will assemble and wire panel

EXTENT: Industrial standards

BLOCK	UNIT	OBJECTIVE
0 2 0 5	0 0 1 0	0 1 5 5

BEST COPY AVAILABLE

156 **CONDITIONS:** Given any one of the basic hand tools which needs cleaning

PERFORMANCE: The student will clean and lubricate the tool

EXTENT: Industrial standards

COURSE	UNIT	OBJECTIVE
[illegible]	0 0 0 1	0 1 5 6

[illegible] **CONDITIONS:** Given a 3 stage transistor, amplifier, VOM, signal generator and oscilloscope

PERFORMANCE: The student will identify the faulty section from the alternatives presented

EXTENT: Correctly

COURSE	UNIT	OBJECTIVE
[illegible]	0 0 [illegible]	0 [illegible] 8

159 CONDITIONS: Given a VOM and 5 resistors, four good ones and one faulty one

PERFORMANCE: The student will determine the faulty resistor

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 0 0 5	0 0 1 2	0 1 5 9

---

160 CONDITIONS: Given a schematic diagram, components drafting equipment, electronic symbol template, and the size of the vector board

PERFORMANCE: The student will design parts layout for vector board

EXTENT: Industrial standards

BLOCK	UNIT	OBJECTIVE
0 0 0 5	0 0 1 3	0 1 6 0

10. CONDITIONS: Given a non-linear algebraic equation and 1/4 inch quadrule paper

PERFORMANCE: The student will identify a plot of the X,Y values and choose from the alternatives presented

EXTENT: Correctly

BLOCK	UNIT	OBJECTIVE
0 3 0 5	0 0 1 3	0 1 6 2

ITEMS

BOOKLET

CRITERION-REFERENCED ITEM BANKING IN ELECTRONICS

by

William Phillip Gorth

and

Hariharan Swaminathan

Center for Educational Research
School of Education
University of Massachusetts
June 1, 1972

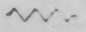
Choose from the list of alternatives presented the resistor value, tolerance, and wattage of the resistor given.

A. Value 10K ohms, Tolerance 10%, Wattage 1/2W
B. Value 100K ohms, Tolerance 20%, Wattage 1W
C. Value 1K ohms, Tolerance 10%, Wattage 1/2W
D. Value 20K ohms, Tolerance 10%, Wattage 1/2W
E. Value 1K ohms, Tolerance 10%, Wattage 1W

****

MATERIALS: 1 - 1K ohms, 10% tolerance, 1/2W carbon color coded resistor.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1 0 1

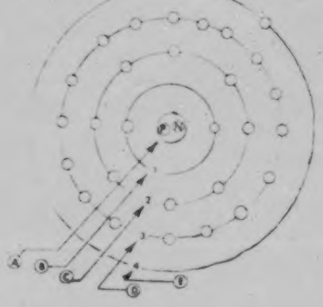
Which of the following components is represented by the symbol  ?

A. Capacitor
B. Fixed resistor
C. Tapped resistor
D. Rheostat
E. Potentiometer

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 1	0 0 0 1	0 0 0 3	0 0 0 3 0 1

Indicate which letter refers to the valance electrons?

A.
B.
C.
D.
E.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 1	0 0 0 2	0 0 0 4	0 0 0 4 0 1

The product of the two numbers 3.14 and 680 (using your slide rule) is

A. 20
B. 46.4
C. 31.6
D. 92
E. 2140

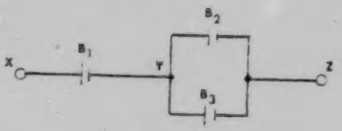
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 1	0 0 0 4	0 0 0 8	0 0 0 8 0 [illegible]

How many amps is 12 milliamps equivalent to?

A. .0012 amps
B. .012 amps
C. .12 amps
D. 120 amps
E. 12,000 amps

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 1	0 0 0 4	0 0 0 9	0 0 0 9 0 1

Connect the three dry cells indicated by the circuit on the right. The voltage between terminals X and Z as measured with your VOM is



A. 0.0V
B. 1.5V
C. 3.0V
D. 4.5V
E. 6.0V

****

Teacher's Instructions?

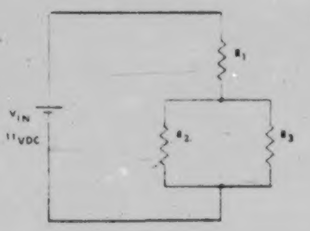
EQUIPMENT: 1. VOM
2. Proper hook-up leads
3. Fresh batteries $B_1 = 1.5V$
$B_2 = B_3 = 4.5V$

Note: Value of batteries must be made obscure in such a manner that student could not calculate required voltage **X-Z**. **Batteries must** be labeled B_1, B_2, B_3.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 2	0 0 0 4	0 0 1 2	0 0 1 2 0 1

Connect the circuit as specified by the figure on the right. The measured values of I_3 and V_3 are

	I_3	V_3
A.	.66 ma	6.6V
B.	1.32 ma	6.6V
C.	2 ma	4.4V
D.	2 ma	6.6V
E.	.66 ma	4.4V



****

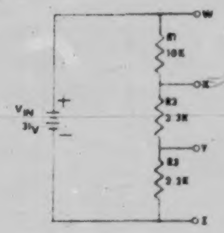
MATERIALS: 1 power supply 0-15V, 1 VOM 20K ohms/V, 260 or equivalent.
R_1 = 2.2K ±5% R_3 = 10K ±5%

NOTE: Component values must be obscured in such a manner that a student cannot calculate the required values by using a formula.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 1	0 0 0 6	0 0 1 3	0 0 1 3 0 1

For the voltage divider circuit shown to the right, across what two terminals would one connect a VOM to obtain a reading of 26.6 volts?

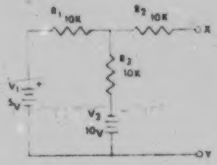
A. W and X
B. X and Y
C. Y and Z
D. X and Z
E. W and Y



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 1	0 0 0 6	0 0 1 4	0 0 1 4 0 1

For the circuit shown to the right, the Thevenin equivalent circuit to the left of terminals X and Y equals which of the following V_{oe} and R_{th}?

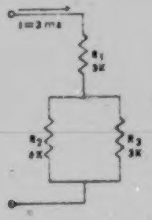
A. -10V and 10K
B. +5V and 10K
C. +15V and 20K
D. -5V and 5K
E. -2.5V and 15K


R1 10K
R2 10K
X
R3 10K
V1 5V
+
V2 10V
Y

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 1	0 0 0 8	0 0 1 5	0 0 1 5 0 1

For the circuit to the right the required input voltage V_{in} is

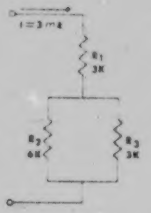
A. 5V
B. 15V
C. 18V
D. 27V
E. 36V


I=3mA
R1 3K
R2 6K
R3 3K

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 1	0 0 0 9	0 0 1 6	0 0 1 6 0 1

For the circuit shown to the right,
the total power dissipated is

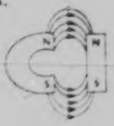
A. 30w
B. 30mw
C. 45w
D. 45mw
E. 90w


I=3mA
R1
3K
R2
6K
R3
3K

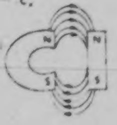
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 1	0 0 1 0	0 0 1 7	0 0 1 7 0 1

What are the correct magnetic fields for the bar and horseshoe magnets shown?

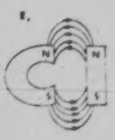
A.



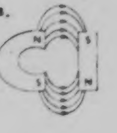
C.



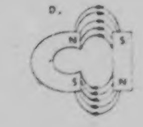
E.



B.



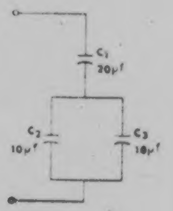
D.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 1	0 0 1 4	0 0 2 2	0 0 2 2 0 1

For the circuit shown to the right, the total capacitance (C_T) between terminals X and Y is

A. 10µf
B. 25µf
C. 30µf
D. 40uf
E. 50µf



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 1	0 0 1 7	0 0 2 7	0 0 2 7 0 1

Measure the resistor provided on an impedance bridge using the materials provided. The value you obtained is

A. 1.00 ohms
B. 1.10 ohms
C. 1.30 ohms
D. 11.0 ohms
E. 1.50 ohms

****

MATERIALS: 1-30 ohms; ±1% tolerance; standard precision resistor.

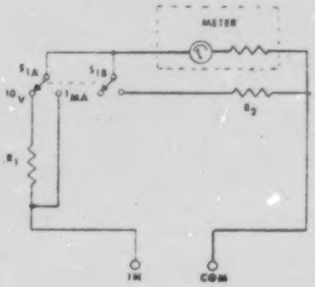
EQUIPMENT: 1 impedance bridge with tolerance of ±1%. (Example - General Radio Type 1650-A)

EXTENT:

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 1	0 0 2 0	0 0 3 3	0 0 3 3 0 1

Given the specific meter movement with a full scale current of 20 µ amps and a meter resistance of 2K ohms, determine the values of R_1 and R_2 for the specified voltage and current range of 10 volts and 1 milliamp. The values you obtained are

	R_1	R_2
A.	410 ohms	4.98K
B.	4.98K ohms	410 ohms
C.	49.8K ohms	410 ohms
D.	49.8K ohms	41 ohms
E.	498K ohms	41 ohms



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 1	0 0 2 0	0 0 3 4	0 0 3 4 0 1

Using the impedance bridge provided measure the capacitance of the capacitor. The capacitance is

A. .1 µf
B. .05 µf
C. 1.5 µf
D. .05 mf
E. .1 mf

****

MATERIALS: Impedance bridge, .1 µf capacitor ±20%, leads if required.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 1	0 0 2 1	0 0 3 5	0 0 3 5 0 1

Using the VOM measure the value of the resistor provided. The measured resistance is approximately

A. 1 ohm
B. 10 ohms
C. 100 ohms
D. 1,000 ohms
E. 10,000 ohms

****

MATERIALS: VOM less batteries; fresh batteries for VOM, 10K ±5% resistor.

Provide student VOM less batteries, student must indicate need for batteries through his zeroing technique.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 1	0 0 2 1	0 0 3 6	0 0 3 6 0 1

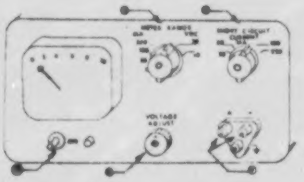
When making a voltage measurement, one should

A. Connect the black test lead to the negative side of the circuit to be measured and the red lead to the positive side of the circuit.
B. Turn on the power in the circuit to be tested.
C. When in doubt as to the voltage present, always use the highest voltage range.
D. Turn off the power in the circuit which is being measured before disconnecting meter leads.
E. Plug the black test lead into the common-jack and the red test lead into the + jack.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 1	0 0 2 1	0 0 3 7	0 0 3 7 0 1

Choose the letter of the control which determines maximum current to be drawn from the power supply.

A. V
B. W
C. X
D. Y
E. Z


METER RANGES
SHORT CIRCUIT CURRENT
VOLTAGE ADJUST

****

MATERIALS: Instructional manual for Hewlett-Packard Power Supply Model 705.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 1	0 0 2 1	0 0 3 9	0 0 3 9 0 1

Determine whether the given capacitor is open, shorted, leaky or has no defects.

A. no defects
B. open
C. shorted
D. leaky

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 1	0 0 2 1	0 0 4 0	0 0 4 0 0 1

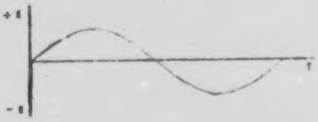
The period of an AC wave whose frequency is 10 kHz is

A. .010 milliseconds
B. .100 microseconds
C. .010 microseconds
D. .03 milliseconds
E. .100 milliseconds

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 2	0 0 0 1	0 0 4 1	0 0 4 1 0 [illegible]

The waveform shown at the right is a

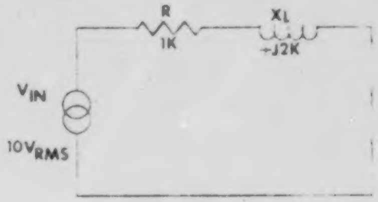
A. Square wave
B. Sinusoidal wave
C. Trapazodial wave
D. Symmetrical wave
E. Sawtooth wave



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 2	0 0 0 1	0 0 4 2	0 0 4 2 0 1

The statement that is true about the circuit shown on the right is

A. V_{IN} lags V_R by 60°.
B. V_{IN} lags V_L by 30°.
C. V_{IN} leads V_R by 30°.
D. V_{IN} leads V_L by 60°.
E. V_{IN} lags V_R by 90°.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 2	0 0 0 4	0 0 4 6	0 0 4 6 0 1

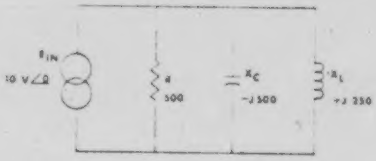
When a 3.18 mh inductor has a frequency of .5 MHz applied to it, the inductive reactance is

A. 1.59K ohms
B. 5K ohms
C. 10K ohms
D. .5M ohms
E. 3.14M ohms

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 2	0 0 0 5	0 0 4 7	0 0 4 7 0 1

For the circuit shown on the right the magnitude of the input impedance (rounded off) and the phase angle are

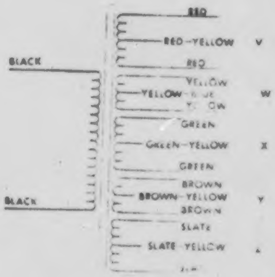
A. 250 ohms +90°
B. 350 ohms +45°
C. 500 ohms 0°
D. 750 ohms -30°
E. 1250 ohms -45°


E_{IN}
10 V∠0
R
500
X_C
-j 500
X_L
+j 250

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 2	0 0 0 6	0 0 4 8	0 0 4 8 0 1

The purpose of winding V in the transformer shown on the right is to supply

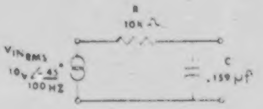
A. Filament No. 1 voltage
B. Filament No. 2 voltage
C. Filament No. 3 voltage
D. High Voltage
E. Rectifier Filament voltage


RED
RED-YELLOW
V
BLACK
RED
YELLOW
YELLOW-BLUE
YELLOW
W
GREEN
GREEN-YELLOW
X
GREEN
BROWN
BROWN-YELLOW
Y
BLACK
BROWN
SLATE
SLATE-YELLOW

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 [illegible] 0 2	0 0 0 8	0 0 5 0	0 0 5 0 0 1

For the R-C circuit shown to the right the magnitude and the phase of the voltage across the capacitor is

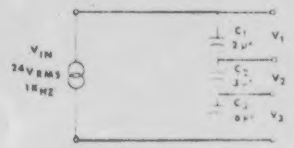
A. 5V rms 0°
B. 5V rms -45°
C. 5V rms $+90^{\circ}$
D. 7.07V rms 0°
E. 7.07V rms -90°


R
10k Ω
V_IN RMS
10V∠-45°
100 HZ
C
.159 µf

[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 2	0 0 0 9	0 0 5 2	0 0 5 2 0 1

For the capacitive voltage divider shown to the right the proper output voltages V_1, V_2, and V_3 are

	V_1	V_2	V_3
A.	4V	6V	12V
B.	8V	8V	8V
C.	4V	8V	12V
D.	12V	6V	4V
E.	12V	8V	4V


V_IN
24V RMS
1K HZ
C1
2µf
V1
C2
3µf
V2
C3
6µf
V3

[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 [illegible] [illegible] 2	0 0 0 9	0 0 5 3	0 0 5 3 0 [illegible]

Connect the components you are given in series. The resonant frequency which is obtained by measurement is

A. 1000 Hz
B. 1500 Hz
C. 10,000 Hz
D. 15,000 Hz
E. 100,000 Hz

****

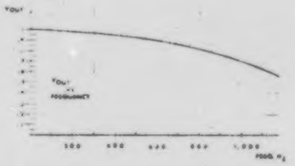
MATERIALS: Sinusoidal oscillator; oscilloscope; resistor (1K ohm) capacitor (.1 pf); inductor (1 mh).

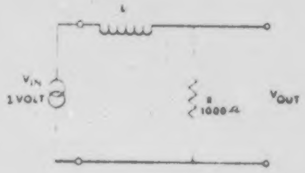
NOTE: Component values must be obscured in such a manner that a student cannot calculate the frequency using a formula. A high Q coil is preferable. The input voltage is not to exceed .1 V_{pp}.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 2	0 0 1 2	0 0 5 4	0 0 5 4 0 1

For the circuit and its frequency response graph, both displayed to the right, the V_{out} versus frequency graph at V_{out} =.707 Vin and 1 kHz will require what values of L?

A. .1 henry
B. .16 henry
C. .32 henry
D. .5 henry
E. 10 henry

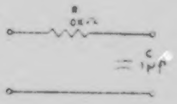




ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 2	0 0 1 3	0 0 5 5	0 0 5 5 0 1

For the R-C circuit shown to the right
the time constant is

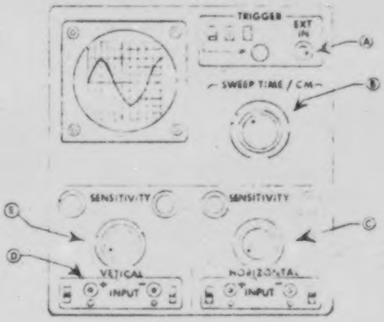
A. 1 microsecond
B. 10 microseconds
C. 1 millisecond
D. 10 milliseconds
E. 50 seconds



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 2	0 0 1 4	0 0 3 6	0 0 5 6 0 1

The letter associated with the control
to measure the period of a sine wave is

A
B
C
D
E


TRIGGER
EXT IN
A
SWEEP TIME / CM
B
SENSITIVITY
SENSITIVITY
E
C
D
VERTICAL
HORIZONTAL
INPUT
INPUT

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 2	0 0 1 5	0 0 5 7	0 0 5 7 0 1

When the (+) of the COM (used as an ohmmeter) is connected to the base and the (-) to the emitter of the transistor, the correct statement is

A. The meter did not deflect indicating that this is an NPN transistor.
B. The meter did deflect indicating that this is an NPN transistor.
C. The meter did deflect indicating that this is a PNP transistor.
D. The meter did not deflect indicating it could be a PNP or an NPN transistor.
E. The meter did deflect indicating it could be an NPN or a PNP transistor.

****

MATERIALS: NPN transistor; VOM

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 3	0 0 0 1	0 0 5 9	0 0 5 9 0 1

Using the materials given, plot the characteristic curves of a germanium diode and determine the barrier voltage. The value you obtained is within the range

A. .6 to .7 VDC
B. .4 to .5 VDC
C. .3 to .4 VDC
D. .1 to .2 VDC
E. .5 to .6 VDC

****

MATERIALS: Germanium diode, 0 to 100 VDC power supply, 10K 1/2W 5% resistor, voltmeter, and milliampmeter.

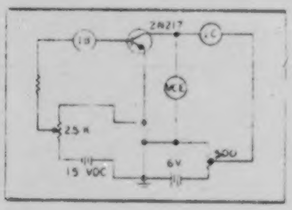
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 1	0 0 6 0	0 0 6 0 0 1

BEST COPY AVAILABLE

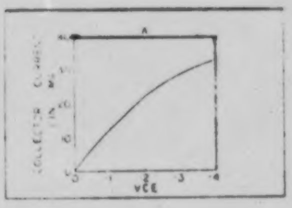
i. Set up the circuit shown on the right.
ii. Set base current I_b to 100 μa and keep it at this level.
iii. Vary the collector emitter voltage (V_{ce}) as shown in the chart below; measure and record the collector current (I_c).

VCE	0	.05	.10	.15	.2	.25	.3	.35	.4	.45	.5
IC											

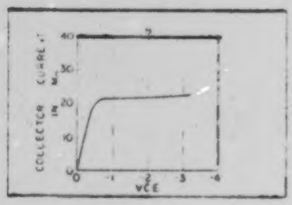
iv. Plot the collector current versus the collector emitter voltage.



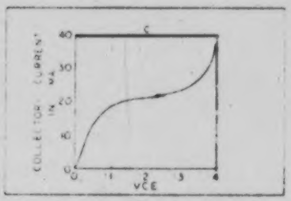
A.



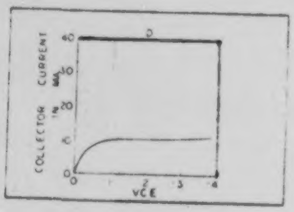
B.



C.



D.

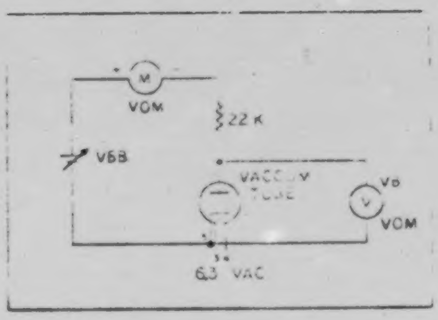


****

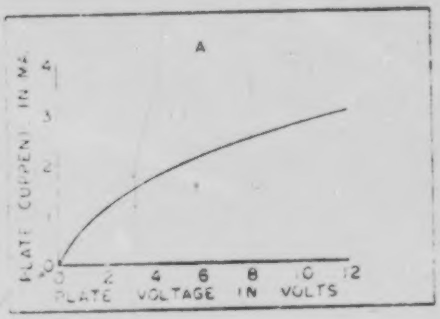
MATERIALS: 2-0 to 10 VDC power supply; 2 VOM; 470 ohm resistor; 2N217 transistor or equivalent; 500 ohm potentiometer; and 2500 ohm potentiometer.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 1	0 0 0 1	0 0 6 1	0 0 6 1 0 1

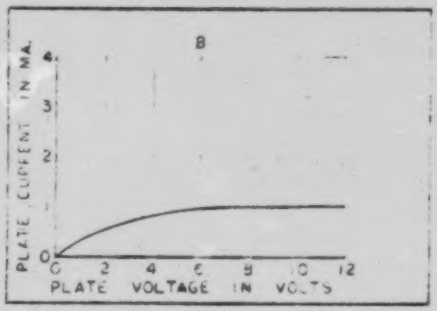
You are asked to plot the characteristics (i.e., plot the graph of plate current versus the plate voltage) of a vacuum tube for the circuit shown on the right. Vary the plate voltage V_p from 0 VDC to 11 VDC in steps of 1 volt and record the plate current for each step. The plot of the characteristics you obtained is best approximated by



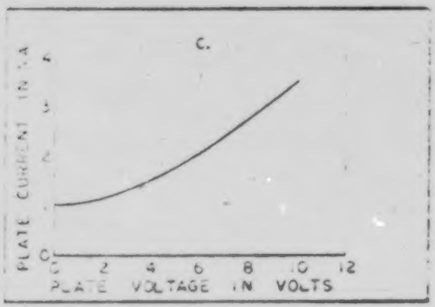
A.



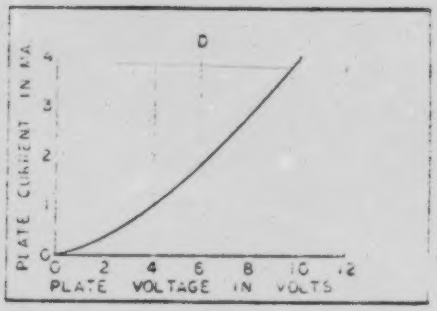
B.



C.



D.

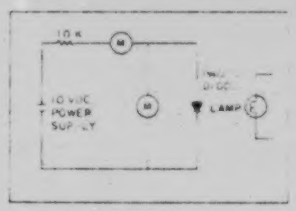


****

MATERIALS: 6 ALS tube with the identification number covered; 0-50 VDC power supply; 6.3 VAC source; 2.2K 1/2 watt 5% resistor; VOM

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 1	0 0 3 8	0 0 5 8 0 1

i. Set up the circuit shown on the right.
ii. Measure voltage drop and current through diode.
iii. Use Ohms Law to calculate the resistance of the diode.



The value you obtained for the resistance is within the range

A. 0-9 ohms
B. 10-49 ohms
C. 50-499 ohms
D. 500-999 ohms
E. 1000-10K ohms

****

MATERIALS: Photo diode with resistance from 1000-10K ohms; 10K 1/2 watt resistor; 10 VDC power supply; VOM; lamp, any type.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 3	0 0 0 1	0 0 6 2	0 0 6 2 0 1

A 6 AVG tube and heater voltage is a

A. Combined Detector and Amplifier with 6.3 VAC heater voltage.
B. Amplifier with a 6.3 VAC heater voltage.
C. Detector with a 6.3 VAC heater voltage.
D. Combined Detector and Amplifier with a 12.6 VAC heater voltage
E. Amplifier with 12.6 VAC heater voltage.

****

MATERIALS: Tube Manual

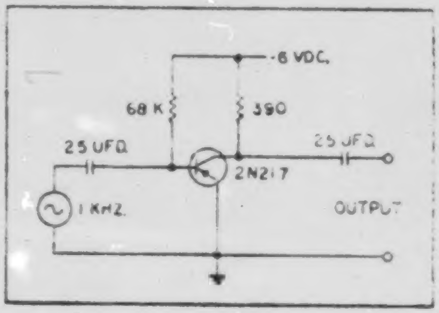
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 1	0 0 6 3	0 0 6 3 0 1

The majority carriers in a P-type material of semiconductors are

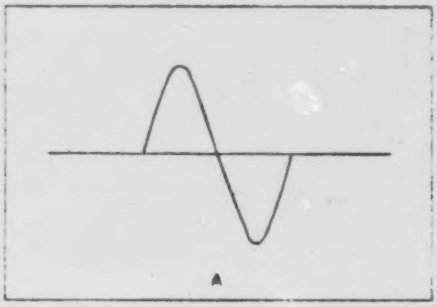
A. Electrons
B. Nutrons
C. Protons
D. Holes
E. Atom

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 3	0 0 0 1	0 0 6 4	0 0 6 4 0 1

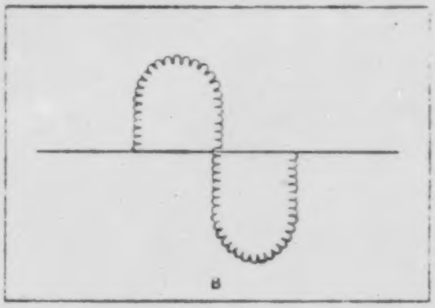
When heat is applied for about 90 seconds to the transistor in the circuit shown on the right, the output waveform looks most like


-6 VDC.
68 K
390
25 UFD
25 UFD
2N217
1 KHZ.
OUTPUT

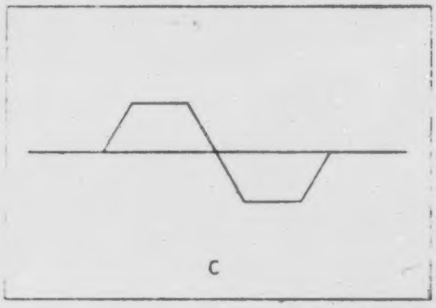
A.



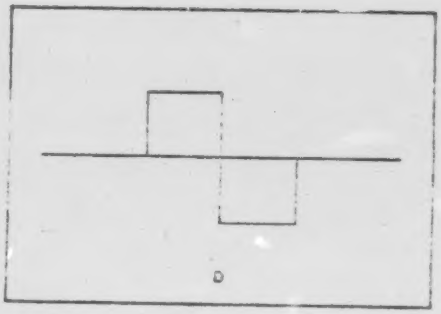
B.



C.



D.



****

MATERIALS: Oscilloscope; heat gun or temperature chamber or equivalent; (Note: a 60 watt lamp could be used.); circuit shown in question.

NOTE: The instructor should set the output to 70% of maximum before distortion occurs.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 2	0 0 6 5	0 0 6 5 0 1

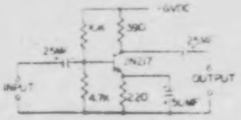
i. For the circuit given set the input signal of the amplifier to 1000 Hz and adjust output signal to maximum before distortion occurs.
ii. Using the oscilloscope determine the phase relationship between the input and output signals.

The phase angle you obtained is

A. 90°
B. 0°
C. 180°
D. 270°
E. 60°

****

MATERIALS: Oscilloscope; signal generator;
6 VDC power supply; and the circuit.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 2	0 0 6 6	0 0 6 6 0 1

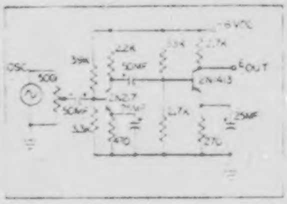
If the tube were in a circuit with resistor R_L = 10K ohms, a 200 VDC source voltage, and grid voltage of -2 VDC, the operating point I/V would be approximately

A. 6 ma/125V
B. 10 ma/150V
C. 20 ma/200V
D. 5 ma/125V
E. 8 ma/150V

****

MATERIALS: 6 CG7 tube; tube manual

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 2	0 0 6 7	0 0 6 7 0 1


+6VDC
OSC
50Ω
39K
22K
50MF
33K
2.7K
E_{OUT}
2N413
2N217
50MF
25MF
3.3K
470
4.7K
270
25MF

i. Set the output of the amplifier at 2.0V_{p-p} at 1000 Hz.

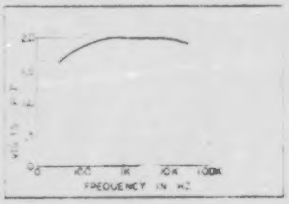
ii. Vary the input frequency as shown below and at the same time maintain a constant input.

FREQUENCY HZ	20	40	60	100	200	500	1K	2K	3K	4K	5K	6K	8K	10K	12K	15K
OUTPUT Vp-p							2.0									

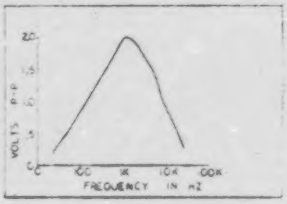
iii. Plot E_{out} against the frequency from the data you have obtained. Use log paper given.

The plot you obtained is best represented by

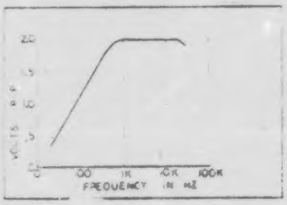
A.



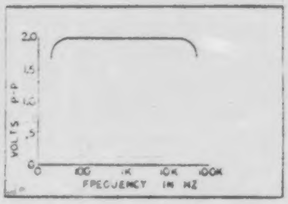
B.



C.



D.



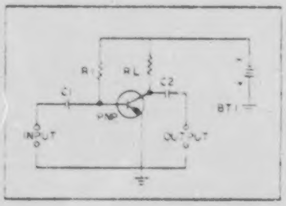
****

MATERIALS: Oscillator; 0-10 VAC, 20 Hz to 20 kHz; oscilloscope; 6 VDC power supply; log graph paper; and circuit.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 3	0 0 0 2	0 0 6 9	0 0 6 9 0 1

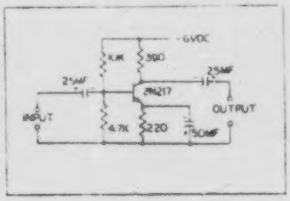
The circuit shown on the right is a

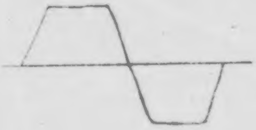
A. Common Emitter
B. Common Base
C. Common Collector
D. Emitter Follower
E. Grounded Grid


R1
RL
C1
C2
PNP
BT1
INPUT
OUTPUT

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 3	0 0 0 2	0 0 7 0	0 0 7 0 0 1

For the circuit shown on the right the output waveform has the shape shown below





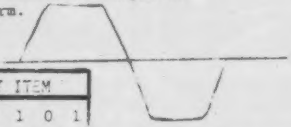
Using the materials given determine which of the following statements is true. The true statement is

A. No V
B. Collector-Emitter short
C. V set too high
D. Input set too high
E. R_L too high in value

****

MATERIALS: Oscilloscope; oscillator 0-10V rms 20 Hz to 20 kHz; VOM; and the circuit.

NOTE: The instructor will increase the input signal until the output is distorted and looks like the following waveform.



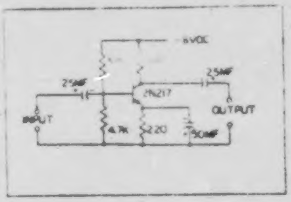
	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 1 0 3	0 0 0 2	0 0 7 1	0 0 7 1 0 1

Determine the gain of the amplifier for the given circuit without causing output distortion. The value you obtained lies

A. Between 3.0 and .5
B. Between 10.0 and 3.5
C. Between 20.0 and 10.5
D. Between 30.0 and 20.5
E. Between 50.0 and 30.5

****

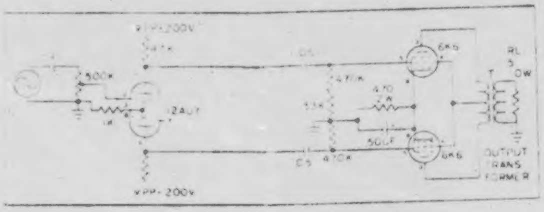
MATERIALS: Oscillator - audio; oscilloscope; 6 VDC power supply; and the circuit.


6VDC
25MF
25MF
2N217
INPUT
OUTPUT
4.7K
220
50MF

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 2	0 0 7 2	0 0 7 2 0 1

If the DC balance of the circuit provided is measured when no input signal is supplied, the correct statement is

A. The plate voltages were the same.
B. The cathode voltages were different.
C. The plate voltages were different due to imbalance of bias.
D. The plate voltages were different due to different characteristics of the 6K6 tubes.
E. Both plate voltages read +200 VDC.



+PP-200V
47K
500K
1K
12AU7
.05
470K
33K
470
2W
50UF
.05
470K
6K6
6K6
RL
5
OW
OUTPUT
TRANS
FORMER
+PP-200V

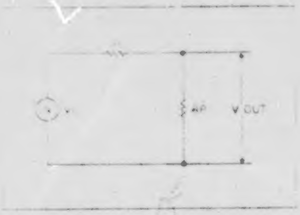
****

MATERIALS: 200 VDC power supply; oscilloscope; oscillator - audio; VTVM or equivalent; and the circuit.

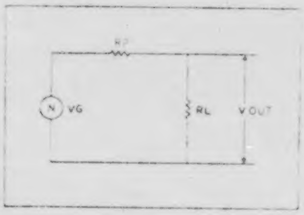
[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 5	0 0 0 2	0 0 7 3	0 0 7 3 0 1

The equivalent circuit of a triode amplifier is

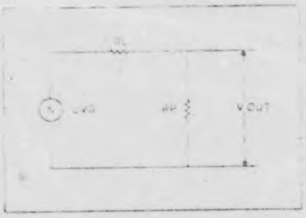
A.



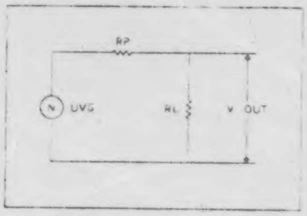
B.


RP
VG
RL
V OUT

C.


RL
UVG
RP
V OUT

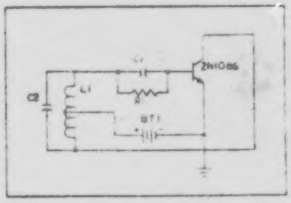
D.


RP
UVG
RL
V OUT

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 3	0 0 0 2	0 0 7 4	0 0 7 4 0 1

In the circuit diagram to the right, the frequency of the oscillator is most affected by

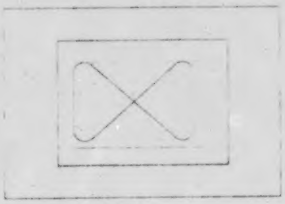
A. Value of L1
B. Type of transistor
C. Value of R1
D. Value of V
E. Value of C2



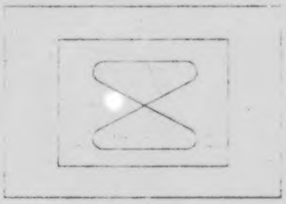
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 1	0 0 0 3	0 0 7 6	0 0 7 6 0 1

If oscillator X is connected to the Vertical channel of the oscilloscope and oscillator Y to the Horizontal channel, the lissajous pattern which is obtained is most similar to

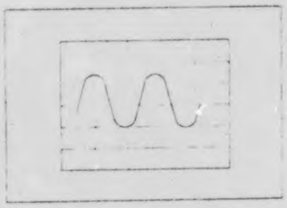
A.



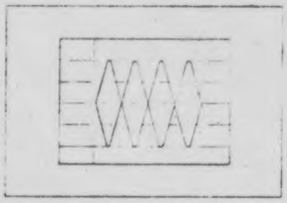
B.



C.



D.



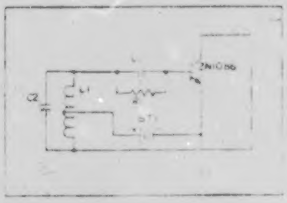
****

MATERIALS: 2 Audio oscillators; oscilloscope.

NOTE: Set one oscillator label X to 1.0 kHz and the other oscillator label Y to 2.0 kHz.

ANS	[illegible]	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 3	0 0 7 7	0 0 7 7 0 1

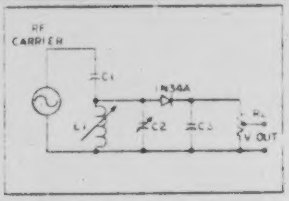
The circuit on the right is a



A. Hartley oscillator
B. Colpitts oscillator
C. Multivibrator
D. Audio oscillator
E. Phase shift oscillator

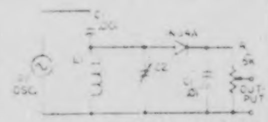
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 3	0 0 7 8	0 0 7 8 0 1

For the Diode Detector circuit shown on the right, the true statement is



A. The circuit rectifies the r.f. carrier and C3 and R_L filters the r.f. leaving the information being modulated.
B. The circuit rectifies the r.f. carrier and C3 and R_L filters the r.f. carrier leaving only DC on output.
C. The circuit rectifies the information being modulated and allows the r.f. signal to go through.
D. The circuit rectifies the modulated information and blocks the r.f. carrier.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 [illegible]	0 0 0 4	0 0 8 0	0 0 8 0 0 1



L1 IS AN ANTENNA COIL, FERRILOOP STICK, OR LOOP ANTENNA THAT RESONATES WITH C2.

For the circuit that is set up

i. Set the r.f. generator to 500 khz.
ii. Using the internal modulator, modulate the carrier by 50%.
iii. Turn R1 for max.mum output.
iv. Record and draw input and output waveforms seen on scope.

The evidence indicates that the circuit is a

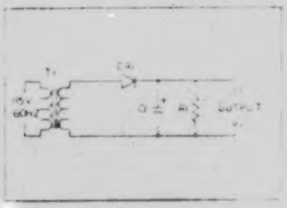
A. Half-wave rectifier
B. Diode circuit
C. Diode detector
D. Diode filter
E. Diode limiter

****
MATERIALS: r.f. generator capable of internal modulation; and the circuit.

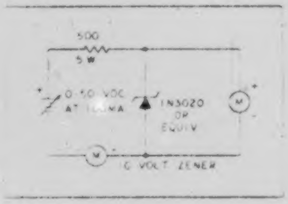
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 3	0 0 0 4	0 0 8 1	0 0 8 1 0 1

The power supply shown on the right is a ______

A. Full wave with RC filter
B. Bridge with RC filter
C. Half-wave with RC filter
D. Series regulated with RC filter
E. Parallel regulated with RC filter


T1
CR1
115V
60Hz
C1
R1
OUTPUT

ENS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 5	0 0 8 2	0 0 8 2 0 1



[illegible] Set up circuit given to bias Zener in forward direction as in the table below.

ZENER VOLTAGE	01	02	03	04	05	06	07
ZENER CURRENT							

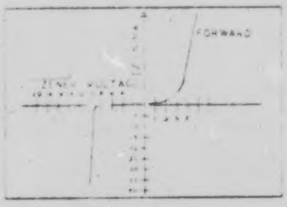
ii. Set up circuit given to bias Zener in reverse direction as in the table below.

ZENER I IN MA		2	3	5	10	20	30	40
ZENER VOLTAGE								

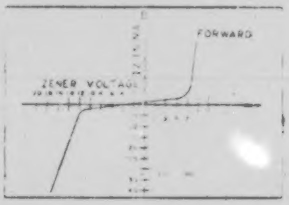
iii. Plot the data you have recorded on one graph of Zener current versus Zener voltage.

The plot you obtained is best approximated by

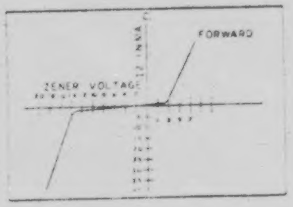
A.



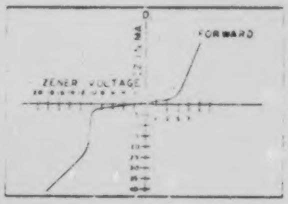
B.



C.



D.

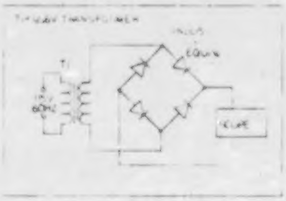


****

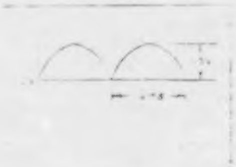
MATERIALS: This circuit diagram and the components attached.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 5	0 0 8 3	0 0 8 3 0 1

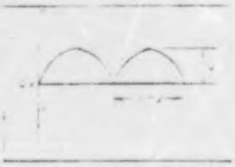
For the circuit that is set up measure the output waveform. The correct waveform is



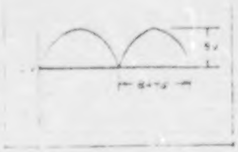
A.



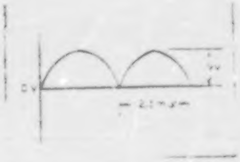
B.



C.



D.

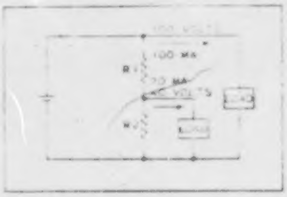


****

MATERIALS: The teacher will supply to the student the following circuit and materials.

[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	[illegible]	0 0 0 5	0 0 8 4	0 0 8 4 0 1

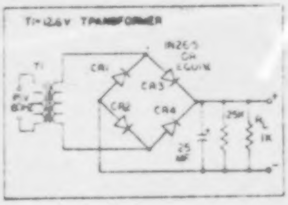
The values of the bleeder resistors R1 and R2 in the circuit shown on the right are .


100 VOLTS
100 MA
R1
20 MA
40 VOLTS
R2
LOAD
LOAD

A. R1 = 2,727 ohms; R2 = 20,000 ohms
B. R1 = 20,000 ohms; R2 = 2,727 ohms
C. R1 = 1,921 ohms; R2 = 20,000 ohms
D. R1 = 20,000 ohms; R2 = 1,921 ohms
E. R1 = 1,715 ohms; R2 = 20,000 ohms

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 5	0 0 8 5	0 0 8 5 0 1

In the circuit provided the percentage regulation of circuit using a load resistor R_L = 1000 ohms is


T1=12.6V TRANSFORMER
1N2C5 OR EQUIV
T1
CR1
CR3
CR2
CR4
25 μF
25K
R_L 1K
+
−

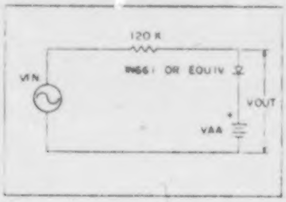
A. Between 1.0% and 4.9%
B. Between 5.0% and 9.9%
C. Between 10% and 14.9%
D. Between 15% and 19.9%
E. Between 20% and 29.9%

****

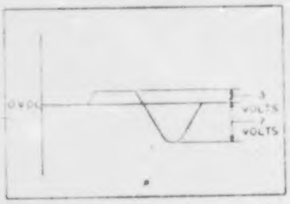
MATERIALS: Supply the materials and circuit to student.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 3	0 0 0 5	0 0 8 6	0 0 8 6 0 1

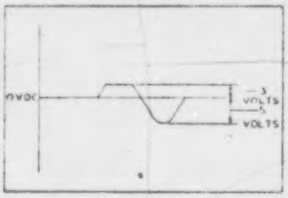
If V_{in} = 10 volts peak to peak and V_{AA} = 3 VDC for the circuit provided, the output waveform looks most like


120 K
1N661 OR EQUIV
VIN
VOUT
+
VAA

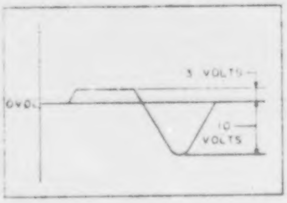
A.


0VDC
3 VOLTS
7 VOLTS

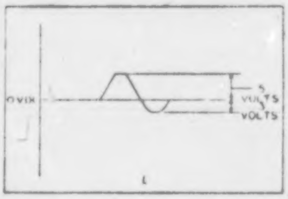
B.


0VDC
3 VOLTS
5 VOLTS

C.


0VDC
3 VOLTS
10 VOLTS

D.


0VDC
5 VOLTS
5 VOLTS

****

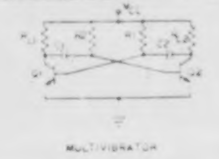
MATERIALS: Supply material and circuit to student.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 6	0 0 8 7	0 0 8 7 0 1

BEST COPY AVAILABLE

For the circuit to the right the components which determine the pulse width on Q1 transistor and on pulse amplitude are

A. C1, R2, and V_{cc}
B. C1, R2, and Q1
C. C2, R1, and V_{cc}
D. C2, R1, and Q1
E. C2, R1, and Q2



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 3	0 0 0 6	0 0 8 8	0 0 8 8 0 1

In the circuit provided the limited on the amplitude of the output waveform are determined by

A. +16 VDC
B. +16 VDC and -6 VDC
C. - VDC and 6K resistor
D. -6 VDC and 1N914 diode
E. +6 VDC and the transistor

****

MATERIALS: Supply the student with materials and circuit.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 3	0 0 0 6	0 0 8 9	0 0 8 9 0 1

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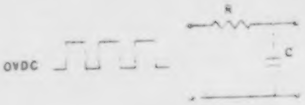
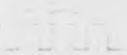
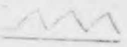
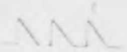
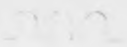
For the circuit diagram shown to the right, the waveform that represents the output is

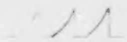


A. 

B. 

C. 

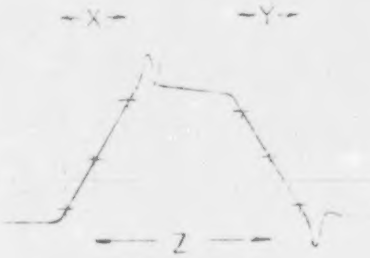
D. 

E. 

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	[illegible]	0 0 0 6	[illegible]	[illegible]

For the waveform shown on the right, the section marked X denotes

A. Rise time (t_r)
B. Rise time (t_f)
C. Turn on time
D. Pulse amplitude left side



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 3	0 0 0 6	0 0 9 1	0 0 9 1 0 1

BEST COPY AVAILABLE

You are given a pair of nichrome and music wire twisted together at one end. Connect the free ends to the terminals of a galvanometer and heat the wires by a candle. Of the following the correct statement is

A. Galvanometer indicates that nichrome wire is negative with respect to music wire.
B. The music wire is positive.
C. The galvanometer points to zero.
D. Wires produce no potential.
E. Both leads are negative.

****

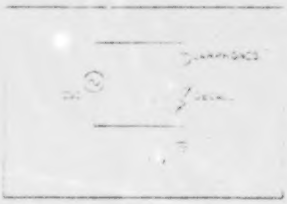
MATERIALS: Supply the student with 10" piece of #18 gauge nichrome wire and [illegible]" piece of .039 diameter music wire. Twist one end of the wires together. Supply the following items to the student: candle; galvanometer, and twisted wire.

Make sure the ends of the wire are scraped clean.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	[illegible]	[illegible] 0 0 8	0 0 0 2	0 0 [illegible] 4 0 1

In the circuit provided, the impedance of the earphones lies in the range of

A. 15,000 to 25,000 ohms
B. 1,500 to 2,500 ohms
C. 17,000 to 23,000 ohms
D. 18,000 to 22,000 ohms
E. 19,000 to 21,000 ohms



****

MATERIALS: Supply the student with the following circuit and materials: decade box; 20,000 ohm earphones; audio oscillator; and oscilloscope.

The procedure is to set the oscillator to $10V_{p-p}$ at 1.0 kHz and measure voltage drop on decade box. Adjust decade box until this voltage is $5.0V_{p-p}$ and read the dials on the decade.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 1 3	0 0 0 8	0 0 0 5	0 0 9 5 0 1

BEST COPY AVAILABLE

Using a 2AP1 CRT and a 400 volt power supply the range of voltages that should be applied to the vertical and horizontal deflection plates with respect to ground is

A. 0 to 400 VDC
B. 300 to 400 VDC
C. 400 to 440 VDC
D. 0 to 40 VDC
E. 360 to 400 VDC

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 1	0 0 0 9	0 0 9 7	0 0 9 7 0 1

When using a CRT Tube Tester the term rejuvenation means

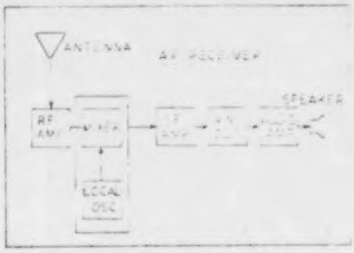
A. An increase in filament voltage
B. An increase in B^+ voltage
C. A decrease in filament voltage
D. A decrease in B_+ voltage
E. A decrease in B^+ and an increase in filament voltage

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 1	0 0 0 9	0 0 9 8	0 0 9 8 0 1

BEST COPY AVAILABLE

In the block diagram of an AM receiver shown on the right, a difference frequency of 456 kHz which contains the same AM intelligence as the original r.f. signal is produced in the block labeled

A. R.F. amplifier
B. Mixer
C. Local oscillator
D. I.F. amplifier
E. Audio amplifier



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 4	0 0 0 1	0 1 0 1	0 1 0 1 0 1

The group of frequencies between 540 kHz and 1600 kHz falls within the band

A. VHF
B. MF
C. LF
D. UHF
E. HF

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 4	0 0 0 1	0 1 0 2	0 1 0 2 0 1

BEST COPY AVAILABLE

Using an Oscilloscope and a pulse generator pre-set by the instructor measure the DC off-set and period. The values you obtained are

A. 10 VDC and 1M sec.
B. 1 VDC and 1M sec.
C. 0.1 VDC and 0.5M sec.
D. 1 VDC and 0.5M sec.
E. 10 VDC and 0.5M sec.

****

MATERIALS. Pulse generator with DC off-set capabilities; oscilloscope, pre-set the pulse generator to a rep. rate of 1 KHz with a 50% duty cycle and an off-set of 1 VDC.

[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 3	0 0 0 4	0 0 9 [illegible]	0 0 9 9 0 1

Using an oscilloscope and a pulse generator pre-set by the instructor measure the P_w, t_r, and t_f. The values you obtained are

A. P_w = 100 usec, t_r and t_f NMT 2 usec.
B. P_w = 10 usec, t_r and t_f NMT 1 usec.
C. P_w = 100 usec, t_r and t_f NMT 3 usec.
D. P_w = 100 usec, t_r and t_f NMT .7 usec.
E. P_w = 100 usec, t_r and t_f NMT 7 usec.

****

MATERIALS: Pulse generator (set to obtain a pulse duration of 100 usec. with a rise time of NMT 7 usec. and a fall time of NMT [illegible] usec.

[illegible]	BLOCK	UNIT	OBJECT	TEST ITEM
[illegible]	0 0 0 3	0 0 0 5	0 [illegible]	[illegible]

BEST COPY AVAILABLE

Using the materials provided you are to identify the faulty component within an inoperative FM receiver. The faulty component is

A. R-F tuned circuit - emitter resistor (R_2)
B. Local oscillator - transformer (T)
C. I.F. amplifier - DC load resistor (R_9)
D. Detector circuit - diode (CR)
E. A.F. power amplifier - voltage divider biasing resistor (R)

****

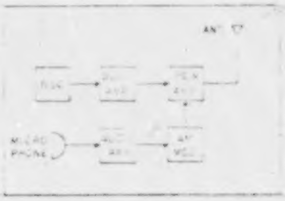
MATERIALS: 1 Philco-Ford "T-rack" FM receiver system with student and instructor lab manuals (or equivalent); 1 opened 1K resistor.

EQUIPMENT: 1 VTVM; 1 oscilloscope.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 1 0 4	0 0 0 1	0 1 0 3	0 1 0 3 0 1

In the block diagram of an AM transmitter shown on the right, the modulated carrier output signal is produced in the block labelled

A. Microphone
B. AM modulator
C. Power amplifier
D. Buffer amplifier
E. Oscillator



ANS	BLOCK	UNIT	OBJECTIVE NO	TEST ITEM
3	0 1 0 4	0 0 0 2	0 1 [illegible]	0 1 [illegible] 0 1

The type of modulation by which the modulating signal varies the frequency of the carrier is

A. PCM
B. PAM
C. AM
D. SSB
E. FM

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 4	0 0 0 2	0 1 0 5	0 1 0 5 0 1

Using the materials provided, you are to identify the faulty component within the inoperative FM transmitter. The faulty component is

A. R.F. oscillator - emitter resistor ($R_{[illegible]}$)
B. Modulator circuit - base resistor ($R_{[illegible]}$)
C. A.F. power amplifier - voltage divider biasing resistor (R_8)
D. R.F. power amplifier - base resistor ($R_{[illegible]}$)
E. Interconnecting lead - between R.F. oscillator and modulator circuit

****

MATERIALS: 1 Philco-Ford "T-rack" FM transmitter system with student and instructor lab manuals (or equivalent); 1 opened 1K resistor.

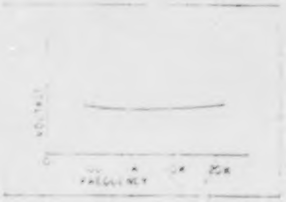
EQUIPMENT: 1 VTVM; 1 oscilloscope.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 0 2	0 1 0 6	0 1 0 6 0 1

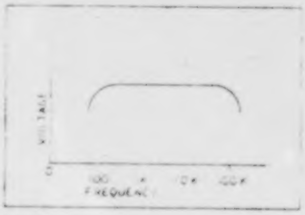
BEST COPY AVAILABLE

Using the test record and phono crystal determine the plot of the output voltage versus frequency. The plot you obtained agrees most closely with

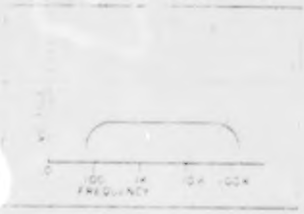
A.



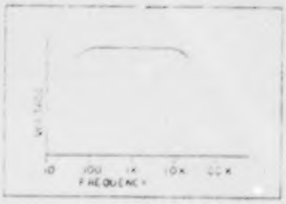
B.



C.



D.



****

MATERIALS: 1 VTVM or equivalent; phono crystal with a frequency response of 20 Hz to 20 kHz with a minimum of ±3.0 dB variation in output; test record that varies the frequency from 20 Hz to 20 kHz.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 4	0 0 0 3	0 1 0 7	0 1 0 7 0 1

A television has no raster but it does have sound and all the filaments are working. The cause of the malfunction is most likely due to

A. Defective AGC circuit
B. Defective UHF tuner
C. Defective RF amplifier
D. Defective low voltage
E. Defective high voltage

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 4	0 0 0 5	0 1 2 0	0 1 . 0 0 1

A Flyback-Yoke Tester is

A. A device to measure voltage on Yoke
B. A device to measure voltage on Yoke and Flyback
C. A device to measure resistance of Yoke and Flyback
D. A device to measure current through Yoke and Flyback
E. A device to determine reactance of Yoke and Flyback

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 [illegible]	0 0 0 5	0 1 1 [illegible]	0 1 1 1 0 1

One of the most dangerous things to do when removing a picture tube is

A. Touching a low voltage supply
B. Dropping the picture tube
C. Forgetting to discharge high voltage
D. Working without safety glasses
E. Working without rubber safety mat on floor

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 4	0 0 0 5	0 1 1 2	0 1 1 2 0 1

The binary equivalent of 43 is

A. 101011
B. 10110
C. 11001
D. 11101
E. 100111

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 1 0	0 1 1 7	0 1 1 [illegible] 0 1

The complement of 0111011 - 0011100 is

A. 0111011
B. 0101110
C. 1100000
D. 1011011
E. 0011111

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 4	0 0 1 0	0 1 1 6	0 1 1 8 0 1

Odd vertical and even horizontal parity is produced for the 5-character word shown on the right by one of the following. The correct answer is

5-Character Word

```
1 0 1 1 1 0
0 0 1 1 1 0
1 1 0 1 1 1
0 1 0 1 0 0
0 0 1 1 0 1
```

A.

```
          0
          1
          1
          0
          1
1 1 0 0 0 1
```

B.

```
          0
          1
          1
          1
          0
1 0 1 0 1 1
```

C.

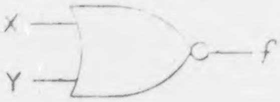
```
          1
          1
          1
          0
          1
1 1 0 1 0 1
```

D.

```
          0
          1
          1
          0
          1
0 1 0 0 0 1
```

AAS	[illegible]	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 [illegible] 0 4	0 0 1 0	0 [illegible] [illegible] 9	0 1 1 9 0 1

The truth table for the circuit at the right is



A.

X	Y	f
0	0	1
0	1	1
1	0	1
1	1	0

B.

X	Y	f
0	0	0
0	1	1
1	0	1
1	1	1

C.

X	Y	f
0	0	0
0	1	1
1	0	1
1	1	0

D.

X	Y	f
0	0	1
0	1	0
1	0	0
1	1	1

E.

X	Y	f
0	0	1
0	1	0
1	0	0
1	1	0

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 4	0 0 1 0	0 1 2 1	0 1 2 1 0 1

The most simplified version of the equation

$$f = \overline{A}\,\overline{B}\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,C\,\overline{D} + \overline{A}\,B\,\overline{C}\,\overline{D} + \overline{A}\,B\,C\,\overline{D}$$

is

A. $f = \overline{A}\,\overline{B}\,\overline{C}\,\overline{D}$

B. $f = A\,D$

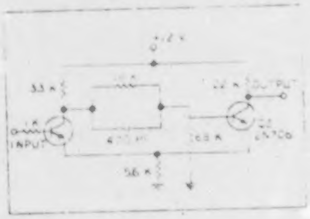
C. $f = A\,B\,C\,D + \overline{A}\,\overline{B}\,\overline{C}\,\overline{D}$

D. $f = A\,\overline{B}\,C$

E. $f = \overline{A}\,\overline{D}$

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 4	0 0 1 0	0 1 2 0	0 1 2 0 0 1

The statement that best describes the circuit shown on the right is



A. This is a two stage amplifier with positive feedback sometimes called a free-running multivibrator, used for generating square waves, timing frequencies, and for frequency division.

B. This is a regenerative bistable circuit wherein the state depends on the amplitude of the input voltage, used for waveform restoration, signal level shifting, signal squaring, and DC level detection.

C. This is a monostable multivibrator which on being triggered switches to its unstable state where it remains for a predetermined time before returning to its original stable state, used for standardizing random pulses and in generating time delayed pulses.

D. This is a two stage amplifier with positive feedback, having symmetrical stages and two stable states, sometimes called a bistable multivibrator.

E. This is a T flip-flop, a bistable multivibrator which changes to the opposite state each time a trigger arrives thus dividing the input frequency by two.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 4	0 0 1 0	0 1 2 2	0 1 2 2 0 1

When triggering a Monostable Multivibrator the output is always

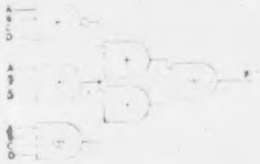
A. Square wave or pulse
B. Sine wave
C. Ramp wave
D. Triangular wave
E. Negative pulse

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 4	0 0 1 0	0 1 2 3	0 1 2 3 0 1

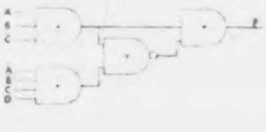
The least amount of logic circuits that will satisfy the truth table shown on the right is

A	B	C	D
2	4	2	1
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

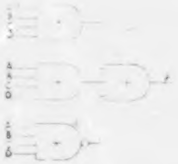
A.


A
B
C
D
A
B
D
B
C
D
F

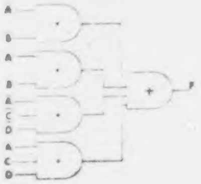
B.



C.



D.


A
B
A
B
A
C
D
A
C
D
F

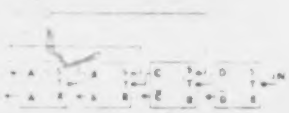
E.

[illegible]		AIT	OBJECTIVE	TEST ITEM
4		0 0 1 0	0 1 1 1	0 1 1 1 0 1

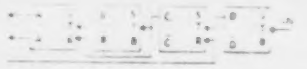
The decade counter that will produce the output represented by the truth table shown on the right is

A	B	C	D
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
0	0	0	0

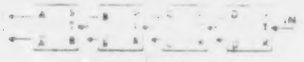
A.



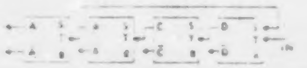
B.



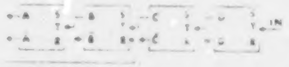
D.



C.

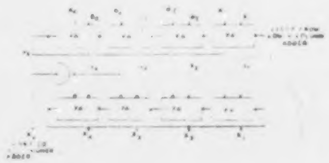


E.



S/S	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 4	0 0 1 0	0 1 2 5	0 1 2 5 0 1

Trace the addition of A and B through the excess 3 adder at the right for A = 5, B = 2 by showing the values of



A_4 A_3 A_2 A_1

B_4 B_3 B_2 B_1

S_5 S_4 S_3 S_2 S_1

X_5 X_4 X_3 X_2 X_1

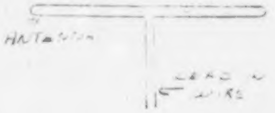
The correct answer is

A.	B.	C.	D.	E.
1 0 0 0	0 1 0 1	1 0 1 0	1 0 0 0	0 0 1 0
0 1 0 1	0 0 1 0	1 0 0 1	0 1 0 1	0 1 0 1
1 1 1 0 1	0 0 1 1 1	1 1 0 0 0	0 1 1 0 1	1 1 0 0 0
0 1 1 0 1	1 1 0 0 0	0 0 1 1 1	0 1 0 1 0	0 1 0 1 0

S/S	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 1 0	0 1 2 6	0 1 2 6 0 1

The type of antenna shown on the right is a

A. Beam antenna
B. Hertz antenna
C. Dipole antenna
D. Rhombic antenna
E. Long Wire antenna



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 4	0 0 1 0	0 1 2 7	0 1 2 7 0 1

Connect the given dipole antenna to a transmitter. Determine the center operating frequency using a grid dip meter. The value you obtained is

A. 27 MHz
B. 50 MHz
C. 100 MHz
D. 3.0 MHz
E. 7.0 MHz

****

MATERIALS: Supply a transmitter or a Function Generator tuned to 27 MHz.
Supply a dipole antenna cut to 27 MHz (Full Wave or half-Wave).

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 1 2	0 1 2 8	0 1 2 8 0 1

Using the oscillator and grid dip meter supplied, determine the resonant frequency of the tank circuit. The value you obtained is

A. 27 MHz
B.* 2.7 MHz
C. 2.7 kHz
D. 27 kHz
E. 270 kHz

****

MATERIALS: Supply a Crystal Controlled Oscillator that is tuned to 27 Mhz.
Supply a standard Grid Dip Meter.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
B	0 0 0 4	0 0 1 7	0 1 2 9	0 1 2 9 0 1

Using the frequency counter supplied, determine the output frequency of the oscillator. The value you obtained is

A. 2.7 kHz
B. 2.7 MHz
C. 27 MHz
D. .27 MHz
E. 27 kHz

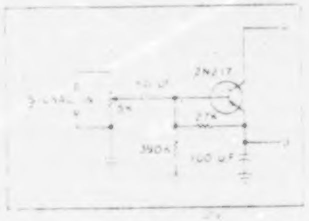
****

MATERIALS: Supply a Crystal Controlled Oscillator whose crystal is 27 MHz.
Supply a 50 MHz electronic counter or equivalent.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 4	0 0 1 7	0 1 3 0	0 1 3 0 0 1

For the amplifier circuit shown below, determine the maximum allowable power using an oscillator set to 6 kHz and an oscilloscope. The value you obtained falls within the range

A. 0 to 500 mwatts r.m.s.
B. 500 mwatts to 1 watt r.m.s.
C. 1 watt to 2 watts r.m.s.
D. 2 watts to 3 watts r.m.s.
E. 3 watts to 4 watts r.m.s.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 1 7	0 1 3 1	0 1 3 1 0 1

A system of long range navigation in which pulsed signals are sent out by two pairs of radio stations and used by a navigator to determine the geographical position of a ship or airplane is called

A. RADAR
B. SONAR
C. LORAN
D. COMMUNICATIONS
E. SHIP TO SHORE

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 4	0 0 1 9	0 1 3 4	0 1 3 4 0 1

Solder the wire to the terminal lug properly so that the wire is positioned parallel to the work bench.

****

MATERIALS: [illegible]" piece of 60/40 rosin core solder, approximately .031 inch diameter, 12" piece of number 22 gauge stranded wire (common type insulation teflon, rubber, etc.); 1 single lug (min.) terminal strip (fastened to board) 1 two inch square piece of fine emery cloth.

EQUIPMENT: 40-60 watt soldering iron and 1 set basic electronic tools.

EXTENT: Solder is smooth flowing and shiny; individual strands of the wire are visible, connection is mechanically and electronically secure; no excess solder; insulation not burnt. Within 1/8" to 1/4" from terminal and running parallel to work bench.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
[illegible]	0 0 0 5	0 0 0 1	0 1 3 6	0 1 3 6 0 1

A screw head with two slots crossed at right angles should be driven by

A. Offset screw driver
B. Nut driver
C. Phillips type screw driver
D. Slotted type screw driver
E. Adjustable wrench

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
C	0 0 0 5	0 0 0 2	0 1 3 7	0 1 3 7 0 1

The American wire gauge of the piece of wire given is

A. No. 0
B. No. 22
C. No. 40
D. No. 20
E. No. 24

****

MATERIALS: 5" length of No. 22 AWG stranded wire with insulation stripped approximately 1/2"; 1 AWG copper wire table showing diameters in Mils.

EQUIPMENT: 1 - 2" to 4" stranded machinist micrometer.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
2	0 0 0 5	0 0 0 2	0 1 3 8	0 1 3 8 0 1

The screw gauge and threads per inch of the machine screw given are

A. 4-40
B. 6-32
C. 10-32
D. 10-24
E. 8-32

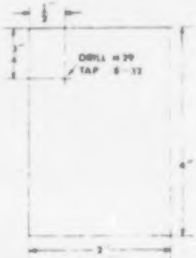
****

MATERIALS: 1 8-32 machine screw (any normal length and type head).

EQUIPMENT: 1 machine screw gauge (which includes 8-32).

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 5	0 0 0 2	0 1 3 9	0 1 3 9 0 1

Drill and tap the aluminum stock to the specifications in the diagram at the right.



****

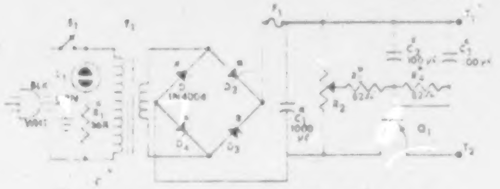
MATERIALS: 1/4" x 2" x 4" ± 1/16" piece of aluminum stock, container of lub or tapping oil; clean rag; diagram as shown; scribe; 4" to 6" bench vise.

EQUIPMENT: 1 12" adjustable square; 1/4" or 3/8" electric drill (or 1/2" drill press); drill bit No. 29; tap wrench; 8-32 tap, scribe.

EXTENT: Dimensions ± 1/16 inch.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 5	0 0 0 2	0 1 4 0	0 1 4 0 0 1

Produce a 1 to 1 single sided taped printed wire layout of the schematic below which will accommodate the components supplied. Size of area to be used is 3 1/4" x 2 3/4". Transistor, transformer secondary, and fuse landing pads to be positioned on the right side of the board. Potentiometer and output terminal landings to be positioned on the left side of the board. All components to be mounted in the horizontal or vertical position.



* COMPONENTS TO BE MOUNTED ON BOARD

NOTE: D1 - D4 1N4004
ALL R ± 10% 1/2 W
ALL CAP. 25WVDC

****

MATERIALS: 12" x 12" sheet of grid paper, 12" x 12" sheet of Mylar paper, (approximate dimensions); 1 roll of 1/16" printed wire tape, 1 roll of .125" x .040" landing pads, components indicated on schematic.

EQUIPMENT: 1 x-acto knife, 1 light table (not mandatory), 6" scale.

EXTENT: No jumper wires used; components positioned to keep conductor length to a minimum; 1/32" minimum separation between conductors and landing pads.

AOC	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 5	0 0 0 4	0 1 4 2	0 1 4 2 0 1

Solder the shielded microphone cable to the microphone connector.

****

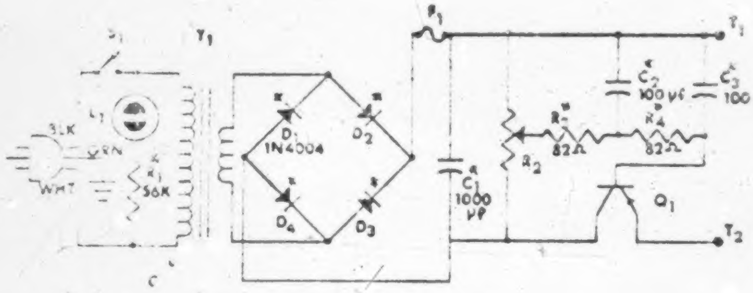
MATERIALS: Microphone connector type 75-MC1F Amphenol (or equivalent), 18" length of shielded microphone cable type Alpha #1703 (or equivalent); 60/40 .031 inch diameter solder.

EQUIPMENT: 1 set basic electronic tools.

EXTENT: Soldering properly done as described in SYNOB 136. Cable shield prepared so as to have no broken or frayed strands and to be present between cable conductors.

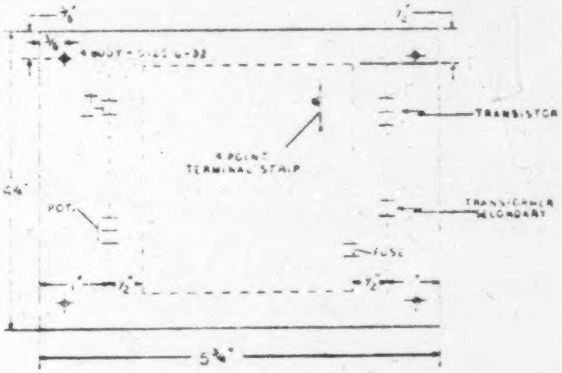
[illegible]	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 5	0 0 0 5	0 1 4 4	0 1 4 4 0 1

Produce a circuit board which is electrically the same as the schematic given. The components are to be mounted in an area 3 1/2" x 2 3/4" and should be in the horizontal or vertical position. Components and wiring are to be fastened to a "vector" board using "flea-clip" terminals. Transistor, transformer secondary, and fuse connections should be positioned on the right side of the board. Potentiometer and output terminals should be positioned on the left side of the board. Wiring may be on both sides of the board.


S1
T1
L1
BLK
GRN
WHT
R1
56K
D1
1N4004
D2
D4
D3
F1
C1
1000 µF
R2
R3
82Ω
R4
82Ω
C2
100 µF
C3
100 µF
Q1
T1
T2

* COMPONENTS TO BE MOUNTED ON BOARD

NOTE; D1 – D4 1N4004
ALL R ± 10% 1/2 W
ALL CAP. 25WVDC


1/8"
1/2"
1/8"
4 BODY-SIZE 6-32
TRANSISTOR
4 POINT TERMINAL STRIP
4 1/4"
POT.
TRANSFORMER SECONDARY
FUSE
1"
1/2"
1/2"
5 3/4"

****

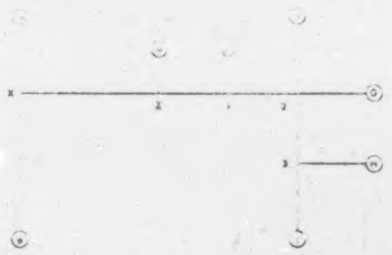
MATERIALS: 4 1/4" x 5 3/4" piece of "vector" board type 85F24EP; approximately 25 "flea-clips" type Vector T28. Components indicated on parts list; 60/40 .031 inch diameter solder.

EQUIPMENT: 1 set basic electronic tools; printed wire vise, (if possible).

EXTENT: Components positioned to maintain conductor length to a minimum, component lead length 1/8" to 1/4"; all soldering to comply to industrial standards. (see SYNOB 136)

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 0 5	0 1 4 5	0 1 4 5 0 1

Select the stranded wires of the proper sizes and make a harness to the specifications shown on the cable layout diagram at the right.



Distance	Dimensions (in.)	Lacing to Termination
A to X	5-1/2	4-1/2 inches from X
X to B	10	1-1/2 inches from B
X to Z	2-1/2	Laced
Z to D	4	2-1/2 inches from D
Z to 1	2	Laced
1 to E	4	1 inch from 1
1 to 2	2-1/2	Laced
2 to F	5	4 inches from F
2 to G	4	3 inches from 2
2 to 3	2	Laced
3 to H	4	2-1/2 inches from 3
3 to I	3-1/2	2 inches from 3

Wire Run No.	Current Handling Capability	From	
101	.8 amps	B (tinned)	
102	.8 amps	D (tinned)	
103	.8 amps	E (tinned)	to A (tinned)
104	3.2 amps	F (tinned)	
105	2 amps	I (tinned)	
106	3.2 amps	I (tinned)	
107	3.2 amps	I (tinned)	
108	.8 amps	G (tinned)	to H (tinned)
109	.8 amps	E (tinned)	
110	2 amps	D (tinned)	

1. All termination stripped and tinned 1/2 inch.
2. Use general rule factor of 500 cir. mils per amp to determine wire size.

****

MATERIALS: 1 cable board approximately 20" x 17" x 1/2" thick; No. 6D finish nails, 15 feet of waxed string; 6 feet of 24 gauge wire; 4 feet of No. 20 gauge wire, and 5 feet of No. 18 gauge wire.

EQUIPMENT: 1 hammer; 12" ruler.

EXTENT: Wires Run No. 101, 102, 103, 108, and 109 are gauge #24; wires 105 and 110 are gauge #20; wires 104, 106, and 107 are gauge #18. Lock stitches approximately 1/2" apart; double lock stitches at all junctions; running stitches running parallel to wire; no wire crossovers in cable run and at junctions; all dimensions ± 1/8 inch; harness is rigged and stiff.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 5	0 0 0 6	0 1 4 0	0 1 4 6 0 1

When using a soldering iron the most important precaution to observe is that

A. the iron must be held in an enclosed holder while not in use.
B. the iron must be plugged into an outlet of the proper current capacity.
C. the solder must be applied to the work and not to the iron.
D. safety glasses must be worn while soldering.
E. no solder must be allowed to fall on the floor.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 5	0 0 0 9	0 1 4 9	0 1 4 9 0 1

Locate in a major distributor's catalog (Cramer satalog or equivalent) a one watt carbon resistor with a 10% tolerance with a value of 1000 ohms. Select from the alternatives provided the correct manufacturer, price, and part number. (Allow for slight price differences.)

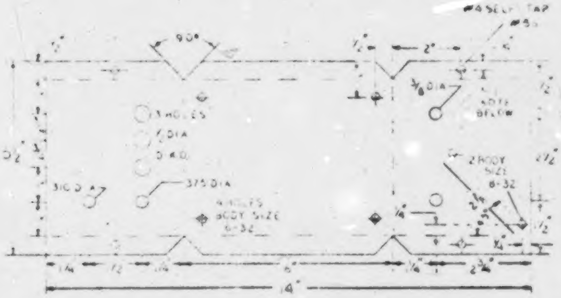
A. Mfr. Allen-Bradley; Price $.30; Part No. GBIK
B. Mfr. MEMCOR; Price $.50; Part No. 1035
C. Mfr. Sprague; Price $.48; Part No. Blue Jacket
D. Mfr. Centralab; Price $1.50; Part No. JWP-102
E. Mfr. Ohmite; Price $.18; Part No. Little Devil

****

MATERIALS: 1 Cramer catalog (or equivalent catalog), 1972 edition.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
5	0 0 0 5	0 0 0 9	0 1 5 0	0 1 5 0 0 1

Construct a mini-box type chassis to the specifications shown on the chassis diagram below


#4 SELF TAP
#35
90°
1/2"
1/2"
2"
3/8 DIA
NOTE BELOW
3 HOLES
1/2 DIA
5 1/2"
2 1/2"
.310 DIA
.375 DIA
4 HOLES
BODY SIZE
6-32
2 BODY
SIZE
6-32
1/4"
1/2"
1 1/4
1/2
1/4
6"
1/4"
2 3/4"
14"

NOTE: USE TEMPLATE PROVIDED WITH TRANSISTOR SOCKET KIT.
#16 DRILL USED FOR ALL SOCKET HOLES

****

MATERIALS: .040" thick sheet of aluminum 6" x 15".

EQUIPMENT: 1 hand brake; 1 corner notcher (or hacksaw); 1 shearer; 1 - 12" flat file, medium cut; 1 scribe; 1 - 12" adjustable square; chassis diagram (provided).

EXTENT: All dimensions ± 1/16 inch.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 1 0	0 1 5 3	0 1 5 3 0 1

Paint the chassis provided.

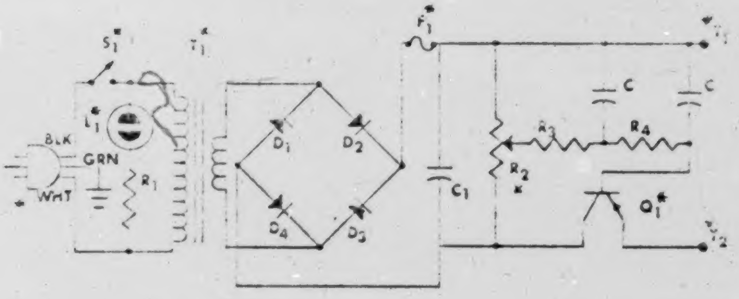
****

MATERIALS: 1 unpainted chassis approximately 4" x 5" x 6" in dimension; (see SYNOB 153) 6" x 6" piece of coarse sandpaper; 1 can (12 oz.) spray paint (or spray gun equivalent); ventilated painting area.

EXTENT: Paint to be smooth and evenly coated, covering all exterior surfaces. Also able to withstand chipping and scratching.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 1 0	0 1 5 4	0 1 5 4 0 1

Mount and assemble the components on the painted chassis provided.



* PART TO BE MOUNTED

****

MATERIALS: painted chassis (see SYNOB 153 and 154); schematic diagram (provided); parts list (as below)

Qty.	Component	Value	Manufacturer
1	* AC cord	3-wire	Belden (or equiv.)
1	*S.P.S.T. toggle switch	120V-3A	------
1	Pilot Lamp Assembly	NE-2	------
1	Filament Transformer	120V pri. 12.6V, 1A sec	------
1	*Potentiometer	5K, 3/4W	------
1	Power Transistor Mtg. Kit	------	Motorola K-15
1	AC cord retainer	------	H.H.S. #
1	Fuse holder	3AG	Little Fuse KLP
1	5-way Binding Posts	Green, Red, Black (ICA)	H.H.S. #

*one single component

HARDWARE: 2-1/2" 8-32 bolts with lock washers

EQUIPMENT: Basic electronic tools

EXTENT: All components securely fastened to withstand normal vibrations. No defacing of painted chassis surface.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 1 0	0 1 5 5	0 1 5 5 0 1

Clean and lubricate the pair of diagonal pliers provided.

****

MATERIALS: 6" x 6" piece of fine emery cloth; general lub oil; 1 clean rag; 1 scribe; 1 pair diagonal pliers with spots of rust and dirt.

EXTENT: Pliers in smooth working order; bluing on handle not removed; joints free from dirt; very light coat oil on pliers.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 1 0	0 1 5 6	0 1 5 6 0 1

Using the materials provided, determine the faulty stage within the 3 stage amplifier. The fault is

A. only in stage #1
B. only in stage #2
C. only in stage #3
D. in stage #1 and #2
E. in stage #2 and #3

****

EQUIPMENT: 1 - 3 stage transistor amplifier (lab type - example Philco "T" rack with plug-in components); an open coupling capacitor - stage #2; 1 VOM; 1 audio signal generator; 1 oscilloscope.

NOTE: The correct response is (C), therefore, the amplifier should be made faulty in stage #3.

ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
3	0 0 0 5	0 0 1 2	0 1 5 8	0 1 5 8 0 1

You are given five resistors numbered from 1 to 5. Using the materials provided, determine which resistor is faulty. The faulty resistor has the number

A. 1
B. 2
C. 3
D. 4
E. 5

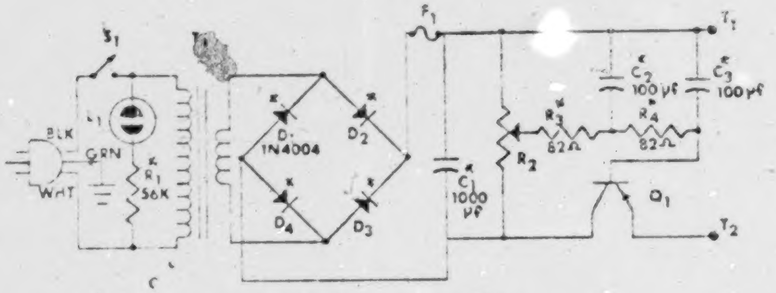
* * *

EQUIPMENT: 1 VOM; 1 each of the following value resistors - 47 ohm, 100 ohm, 1K, 10K 100K.

NOTE: The 10K resistor being faulty, wattages and types not specified.

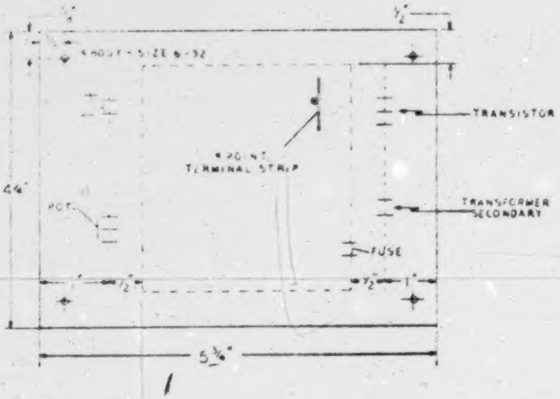
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
4	0 0 0 5	0 0 1 2	0 1 5 9	0 1 5 9 0 1

Produce a parts layout diagram for the parts shown on the schematic provided. Components must be accommodated within the area shown on the partially completed parts layout diagram and mounted horizontally or vertically. Wires must all be bent at 90 degree angles; 4 wire maximum at each connection point.


S1
L1
BLK
GRN
WHT
R1
56K
T1
D1
1N4004
D2
D4
D3
F1
C1
1000 µf
R2
R3
82Ω
R4
82Ω
C2
100 µf
C3
100 µf
Q1
T1
T2

* COMPONENTS TO BE MOUNTED ON BOARD

NOTE: D1 – D4 1N4004
ALL R ± 10% ½ W
ALL CAP. 25WVDC


½"
½"
½"
4 HOLE – SIZE 6-32
4 POINT TERMINAL STRIP
TRANSISTOR
TRANSFORMER SECONDARY
POT.
FUSE
4¼"
1"
½"
½"
1"
5¾"
/

****

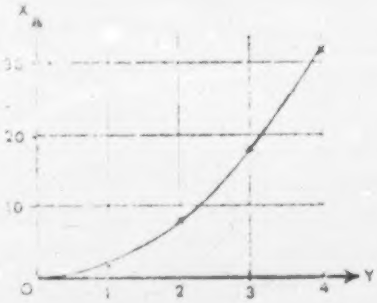
MATERIALS: Drafting board; 18" T-square; 9" 30°, 60°, 90° triangle; scale; schematic; partially completed parts layout; components indicated on schematic.

EXTENT: Components positioned to keep wire length to a minimum; components mounted in a horizontal or vertical position; component lead length 1/4 to 3/8 inch; all 90° wire bends; 4 wires maximum at each connection point; approximately 25 connection points.

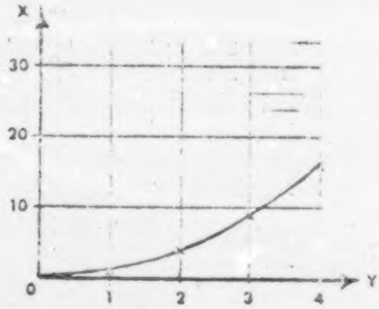
ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
	0 0 0 5	0 0 1 3	0 1 6 0	0 1 6 0 0 1

Which of the following is a plot of the function $X = 2y^2$?

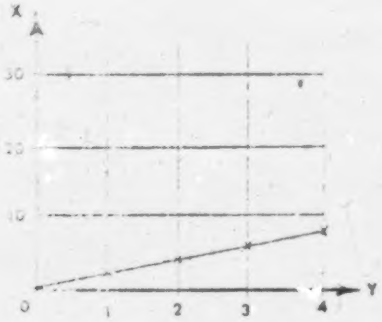
A.



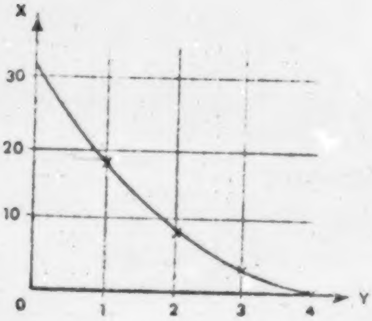
B.



C.



D.



ANS	BLOCK	UNIT	OBJECTIVE	TEST ITEM
1	0 0 0 5	0 0 1 3	0 1 6 2	0 1 6 2 0 1